ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

VOL. XL. No. 4.

TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK 47-64

Ten-Wheel Passenger Locomotives; Grand Trunk Ry. (illustrated) 50

New Ship Canal Entrance to Harbor of Duluth, Minn. (with two-page plate) 50

A Test of the Hardness of Cast Iron 51

A New Type of High Potential Insulator (illustrated). 51

The Cost of Boiler-Room Labor 51

A New Continuous Recording or Integrating Engine Indicator (illustrated) 52

The Engineer as a Useful Member of Society 53

Experiments Upon the Durability of Different Metal Coatings Immersed in Sea Water 54

The Calhoun Placer Mining Machine (illustrated) 54

Legal Decisions of Interest to Engineers 55

Weather Report for June 55

A Year's Progress in Engineering 59

Comparison of Recent Specifications for Fineness and Tensile Strength of Cements 61

A Gasoline Hoisting Engine (illustrated) 62

Rock-Filled Dams in California (illustrated) 62

Book Reviews 64

EDITORIAL NOTES 56

Comments of "The Engineer" on the Naval Battle at Santiago—The Falling Off in the New York Canal Traffic—A Test of an Air Cushion at the Bottom of an Elevator Shaft.

EDITORIAL:

The Value of High Short-Time Tensile Strength Tests for Hydraulic Cements 57

LETTERS TO THE EDITOR 58

The Patents on the Diesel Motor—Frog Angles and Crossing Frogs (illustrated)—The Report on the Condition of the Paints on the 155th St. Viaduct, New York city—Gould's "Arithmetic of the Steam Engine"—Notes and Queries.

THE SPEED PROPOSED FOR THE NEW BATTLESHIPS has been modified by the Navy Department in a notice to shipbuilders dated July 26 as follows:

The Department will in awarding contracts for the construction of battleships Nos. 10, 11 and 12, under its advertisement of June 7, give preference, other things being equal, to such bids as offer to guarantee the highest rate of speed and greatest coal endurance, the total weights of engines, boilers and coal, and the spaces allowed therefor, to remain as now fixed by the circular defining the chief characteristics of said vessels, and the Department plans and specifications and the vessels to have a steaming radius of not less than 5,432 knots at a speed of 10 knots per hour.

The original circular referred to specified the weight of coal to be carried as 1,200 tons; the weight of engines, boilers and all machinery in the engineer's department at 1,130 tons; the normal displacement at 11,500 tons, with a length over all of 368 ft., and a beam at the water line of 72 ft. Cylindrical single-ended boilers and four-cylinder triple-expansion engines were also specified.

BIDS FOR THE TORPEDO-BOATS AND TORPEDO-boat destroyers, which shipbuilders are now preparing, are not to be opened until Aug. 16, the date having been postponed to give some firms on the Pacific coast more time to prepare their proposals. It is said that thus far there have been comparatively few inquiries for the plans and specifications for these vessels. The high grade of workmanship and material which the government requires has caused several of the contractors to lose on the vessels of this type already built.

THE BRITISH NAVY is to be increased by six new battleships and twelve torpedo-boat destroyers, according to the statement of the First Lord of the Admiralty, Geo. J. Goschen, on July 22. The original naval programme provided for only two additional battleships to be begun this year; but the number was increased on account of information that Russia proposed to build six battleships this year. It is now reported, however, that Russia has greatly reduced its contemplated expenditure for the enlargement of its navy.

THE CONTRACT FOR TRANSPORTING THE SANTIago prisoners back to Spain was awarded by the government to the Campania Transatlantica, at a rate of $55 for officers and $20 for enlisted men. It will be seen that this rate is far below the bid made by a combination of the principal transatlantic steamship lines as given in this column last week. The United States also gains in that its responsibility from an international point of view, and the liability to complications, will be much less than if the prisoners were transported under a neutral flag.

THE "CRISTOBAL COLON" may yet be rescued and become a part of the United States Navy. If she is not it will not be for lack of energy on the part of Lieut. R. P. Hobson, Naval Constructor, U. S. N. The report of the expert of the Merritt Wrecking Co. who examined this vessel was that it would be impossible to float her; but the naval constructor was impressed with the possibility of righting the hull by the use of pneumatic caissons. He made a flying trip to Washington, secured the approval of the Navy Department, and the co-operation of the chief officers of the wrecking company, and a strong effort will be made to save this fine vessel before the hull is broken up by heavy seas.

THE U. S. PROTECTED CRUISER "CHICAGO," after about two years spent in alteration, is very nearly ready for service. The "Chicago" was authorized in 1883 and launched in 1885, and was one of the first of the "new navy." She was then equipped with a twin-screw compound overhead beam engine of 5,084 I. HP., giving her a trial speed of 15.3 knots. Her main battery included four 8-in., eight 6-in. and two 5-in. breech-loading rifles, with a secondary battery of nine 6-pdr. and four 1-pdr. rapid-fire, and two Hotchkiss and two Gatling guns. She was bark-rigged. The "Chicago" is now greatly changed. Her engines are of the twin-screw, slightly inclined triple-expansion type, with 9,000 I. HP., and these are intended to give her a speed of 18 knots. She is fitted with appliances for forced draft, on the closed fire-room system, with smokestacks 80 ft. high for natural draft. The advance in marine engine design, since the "Chicago" was launched, is made evident by the fact that her new engines, though almost twice the power of the original ones, weigh about 135 tons less. The vessel was originally provided with cylindrical externally fired boilers in brick settings, which were obsolete for naval use even when they were designed. These have been removed and in their place have been installed four single-ended Scotch boilers and six Babcock & Wilcox marine boilers. The former will be used for ordinary cruising and the latter only when it is desired to run at higher speeds. In her main battery the four 8-in. guns have been retained, but fourteen 5-in. rapid-fire guns have been substituted for the other breech-loading guns. The secondary battery now has seven 6-pdr. and two 1-pdr. rapid-fire guns, and two Colts' and one field gun. The masts of the ship have been replaced by military tops and her protective deck has been extended. The "Chicago" is 325 ft. long, 48 ft. 2 ins. extreme beam, 19 ft. mean draft, 4,500 tons displacement and 3,042 gross tonnage. She has a complement of 33 officers and 376 men.

THE CUBAN ORE MINES of the Spanish-American Iron Co., at Daiquiri, 19 miles east of Santiago, on whose steel pier and docks were landed most of Gen. Shafter's army, have several contracts on hand for the delivery of ore in Great Britain. For two years the mines were working under the protection of Spanish troops, but just before these troops retreated from Daiquiri they burned the roundhouse and shop of the company. These will be rebuilt and operations will be resumed at once.

THE IRON ORE PRODUCTIONS OF SPAIN in 1897 amounted to 7,468,000 tons, as compared with 6,762,000 tons in 1896. Of this product the Biscayan mines contributed 5,170,000 tons; Santander mined 800,000 tons; Murcia, 470,000 tons; Seville, 330,000 tons, and Almeria, 300,000 tons. Nearly all of this ore is exported, England taking 5,000,000 tons; Germany took 1,000,000 tons; France, 500,000; Belgium, 200,000 tons, and 60,000 tons went to the United States. Spain herself converts but a very small part of this ore; the Spanish production in 1897 only amounted to 297,000 tons of ingots, 63,000 tons of Siemens steel and 134,000 tons of structural iron.

A NEW STEEL PLANT is about to be built at Pullman, Ill., by a company of German capitalists, according to a press dispatch from Chicago. It is said that 20 acres of ground are to be covered with buildings, and that the plant will be one of the largest steel producing works in America. The news is important if true. It will require a very long purse to start a successful steel works. In order to compete with existing works it should have its own ore mines on Lake Superior, its own coal mines and coke ovens, and its own steam vessels and ore and coal docks, all of which means an expenditure of many millions of dollars.

TWO OF THE LARGEST STEEL PLATES ever made were rolled at the South Chicago Works of the Illinois Steel Co., on June 3. They were for the shells of consolidation locomotive boilers. The sheets before shearing measured 128 × 360 ins. and 130½ × 375 ins. Each was sheared into a plate 124 ins. wide, 220 ins. long on one side and 237 ins. on the other. The plate gaged at the four corners 0.577, 0.577, 0.574 and 0.576 ins., and at the ends near the middle 0.640 and 0.623 ins.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on July 22 at Dutch Flat, Cal., on the Southern Pacific R. R. The boiler of the locomotive of an eastbound train blew up while the train was standing at the station. The engineer, the fireman and a coal passer were killed and several others were slightly injured.

A WATER-WORKS TANK BURST at Beemer, Neb., on July 13, according to a press dispatch. It is stated that the hoops gave way at the riveted joints, and that the tank fell 25 ft.

A BROKEN SHAFT on the steamer "Friesland," of the Red Star Line, from Antwerp to New York, was repaired in mid-ocean, 1,450 miles from New York, on July 15, in such a manner as to allow the steamer to complete her voyage at seven knots, or about half her usual speed. The shaft was 16 ins. diameter, and a crack was discovered in it running around two-thirds of the circumference and 13 ins. through the shaft, the crack being open ½-in. at the widest point. The break was between the thrust block and the low-pressure crank. The temporary repair was made by a steel clamp and ½-in. wire wrapped tightly around the shaft. The wire was wound like thread on a spool by slowly turning the engine. The low-pressure cylinder was disconnected, and the vessel proceeded at reduced speed, arriving in port three days late.

AN ORDER FOR 500 COMPLETE STREET RAILWAY car equipments, including 1,000 25-HP. motors, 1,000 controllers and 500 trolleys, is reported to have been received by the Walker Co., Cleveland, O., through its Paris agency. The apparatus will be used in Italy, France and Germany.

BIDS FOR A STREET RAILWAY FRANCHISE between Elizabeth and Plainfield, N. J., will be received on Aug. 4 by the Freeholders of Union Co., N. J., at the Court House in Elizabeth. The Freeholders are acting under a law which provides for the widening, strengthening and grading of highways under the control of such bodies, and for the constructions of railways thereon. The estimated cost of widening the streets in question is about $350,000. Messrs. Frank J. Hubbard and J. F. Bauer, of Elizabeth, are the engineers for the county and Mr. S. Rusling Ryno is Clerk of the Freeholders.

ALL ELECTRIC WIRES IN NEW ORLEANS must be placed underground, in accordance with an ordinance passed several months ago. It is said that applications for space in the conduits have been filed by the Edison Electric Light Co., two telegraph and one telephone companies, all foreign corporations, but that no action towards compliance with the ordinance has yet been taken by companies operating under Louisiana charters.

BIDS FOR AN ELECTRIC LIGHTING PLANT are called for by the Shanghai, China, municipal council through F. S. Blackall, of Blackall & Baldwin, 39 and 41 Cortlandt St., New York city. The apparatus will include the two 100-K-W. alternators, direct connected to horizontal medium speed engines, water-tube boilers, switchboard, switches and instruments. Sealed proposals must be sent not later than Aug. 10 to the above address.

THE TRUSTEES OF THE SANITARY DISTRICT OF Chicago have vetoed the scheme of certain private parties to use the water from the drainage canal at its southern terminus for water-power development. They have taken the very proper ground that the water power which the canal will create is the property of the Sanitary District and if it is developed it should be developed for its benefit.

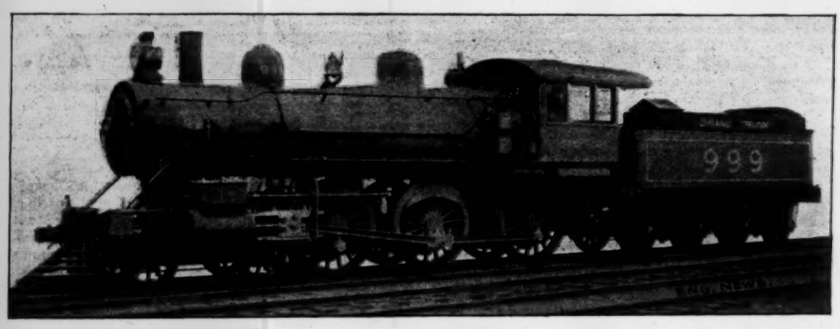
THE FRENCH SOCIETY OF CIVIL ENGINEERS, on June 10 and 11, celebrated the 50th anniversary of its foundation. There was a meeting at the Society House and speeches were made by M. Loreau, the President of the Society, and by the representatives of other societies, and a paper was read on the Alexander III. bridge by M. Alby, the engineer in charge. On June 11 the bridge of Alexander III. was visited, and in the afternoon there was a reception attended by the President of the French Republic and by M. Turrel, the Minister of Public Works, and at this meeting a number of orders were awarded to engineers by President Felix Faure. In the evening there was a brilliant reception with a great number of guests present. On June 13 the ceremonies terminated in a banquet of 500 covers at the Hotel Continental. This society was founded in 1848 and now has about 3,200 members.

THE SEPTIC TANK SYSTEM of sewage treatment was vigorously discussed at the recent meeting of the Incorporated Association of Municipal and County Engineers at Edinburgh, Scotland. Mr. Donald Cameron, City Surveyor of Exeter, and patentee of the system, sent a paper to the meeting which opened up the subject. The paper contained nothing new, but stated that the system was working most satisfactorily at Exeter, where about 65,000 gallons of sewage has been treated daily for 22 months with "no sign of requiring the removal of the deposit" from the tank. The majority of those who took part in the discussion, as reported in "The Surveyor," seemed to consider the system as still in an experimental stage. Several intimated that merely prefixing the word "bacterial" to variations of a well-known and long-practiced system of sewage treatment neither made the variation a new system of treatment nor increased the efficiency of the process. Some objections were urged, also, to the patenting of engineering inventions by engineers.

TEN-WHEEL PASSENGER LOCOMOTIVES; GRAND TRUNK RY.

The Grand Trunk Ry. has recently added to its equipment some large and powerful passenger locomotives of the ten-wheel type, which type of engine is coming to be very generally used for fast and heavy passenger service. A side view of the engine is more striking than the view shown in the accompanying cut, the long boiler being set very high, so that it is entirely above the wheels, which are 6 ft. in diameter. The appearance of the engine is somewhat peculiar, as it is painted black all over (including the boiler jacket), and this sombre color is relieved only by a very little bright work and lettering. All the lettering and striping is in aluminum leaf.

The boiler is of the extended wagon-top pattern, with a wide and shallow firebox dropped low at the front. The main steam dome and the special dome for the whistles and safety valves are mounted on the wagon top, the bell being on the throat sheet and the sandbox on the forward end of the barrel. All the rods are of I-section, and the side rods have solid ends. The engine is fitted with a 9½-in. Westinghouse air pump for the brakes and the air signal. The tender is mounted on two trucks with 43-in. wheels, which is much larger than is common in American practice, as shown in our issue of June 9. Six of these engines were built in April last by the Schenectady Locomotive Works, of Schenectady, N. Y., and we are indebted to the builders for the photograph from which the accompanying cut is prepared. The following is a list of the principal dimensions, given in our standard form:



TEN-WHEEL PASSENGER LOCOMOTIVE; GRAND TRUNK RY.
Schenectady Locomotive Works, Builders.

Ten-Wheel Passenger Locomotives; Grand Trunk Ry.

Running Gear.	
Driving wheels, (6) diameter	6 ft. 0 ins.
Truck wheels, (4) "	3 " 1 "
Tender wheels, (8) "	3 " 7 "
Driving-wheel centers, main	Cast steel.
Others	Steeled cast iron.
Truck and tender wheels	Steel tires.
Drvg. whl. tires secured	Shrinkage and retaining rings.
Engine truck	Swing center.
Journals, driving axles	9½ × 12 ins.
Wheelbase—Driving	15 ft. 8 ins.; Truck 6 ft. 6 "
Total engine	26 " 11 "
Tender	16 " 6½ "
Engine and tender	53 " 9 "
Truck-pin to c. of lead. driv. wheel	8 " 0 "
Wheels having blind tires	Second pair.
Weight in Working Order.	
On driving wheels	124,990 lbs.
On truck wheels	41,000 "
Engine, total	165,190 "
Water in tank	37,500 "
Coal on tender	20,000 "
Weight of piston and rod	439 "
Weight of crosshead	346 lbs.; Main rod 711¼ "
Weight of front side rod	338 "
Back side rod	263 "
Cylinders.—(2)	20 × 26 ins.
Crosshead and guides	Alligator type.
Connecting rod, length between centers	10 ft. 8¼ ins.
Side rods	Solid ends.
Valve Gear.—Type	Stephenson link.
Ports, steam	20 × 1⅝ ins.; Ports, exhaust 20 × 3 ins.
Bridges, width	5 "
Bridges, width	1⅝ "
Eccentrics, throw	5 "
Slide valves, balanced; max. travel	5½ "
" " ins. clearance	⅛ in.; outs. lap. 1 "
" " lead in full forward gear (blind)	1-16 "
" " lead at 6 ins. cut-off, forward	¼ "
Boiler.—Type	Extended wagon top.
Diam. barrel, inside smallest ring	5 ft. 0 11-16 ins.
Dome, diameter	2 " 7½ "
Thickness, barrel plates	21-32 and ¾ in.
Smokebox tube-plate	⅝ "
Horizontal seams	Sextuple riveted.
Circumferential seams	Double riveted.
Joints	Butt.
Height from rail to center line	8 ft. 9½ ins.
Length of smokebox, includ. extension	5 " 5 "
Does smokebox arrangement conform to M. M. Assoc rules?	Yes.
Injectors (2)	Hancock inspirator.
Working steam pressure	200 lbs.
Firebox.—Type	Wide, shallow; radial stays.
Length inside	10 ft. 7 ins.; width inside 3 ft. 4⅛ ins.
Depth at front	6 " 4¾ " depth at back 5 " 5 "
Thickness, side plates	5-16 in.
" back plate	⅜ "
" crown plate	⅜ "
" tube plate	½ "
Crown stays	radial; Grate bars rocking.
Is fire-brick arch used?	Yes.
Stay bolts (drilled), diameter	1 in.
" " pitch	about 3⅞ ins.
Water spaces front and back	4 "
" " sides	3½ "
Tubes.—(Iron), Number	291
Thickness	No. 12 W. G.; Pitch 2¾ ins.
Diameter, outside	2 "
Length over tube plates	15 ft. 0 "
Heating Surface and Grate Area.	
Heating surface, tubes (exterior area)	2,269.63 sq. ft.
" " firebox	185.85 " "
" " arch tubes	15.15 " "
" " total	2,470.63 " "
Grate area	33.44 " "
Miscellaneous.	
Exhaust nozzle (single), diameter	4¾, 5, 5¼ and 5½ ins.
" " distance below c. line of boiler	1½ "
Smokestack, diameter at top and base	16 "
" height above smokebox	3 ft. 1 in.
" height of top above rail	14 " 7¼ ins.
Capacity of tender tank	4,500 gallons.
Capacity of coal space	20,000 lbs.
Brake fittings, Westinghouse-American, outside equalized.	

NEW SHIP CANAL ENTRANCE TO THE HARBOR OF DULUTH, MINN.

(With two-page plate.)

The ship canal entrance to the harbor of Duluth, Minn., has been protected for some years past by two parallel piers, about 240 ft. apart and somewhat over 1,200 ft. in length. The increased size of the vessels now used on the lakes and the phenomenal growth of lake commerce have demanded the general improvement of this harbor and its entrance. Plans for the work were prepared some time ago under the supervision of Major Clinton B. Sears, Engineer Corps, U. S. A., in charge of government work on Lake Superior, and work is now in progress.

The harbor of Duluth now consists of the Duluth Canal, the Wisconsin entrance, Superior Bay, Allouez Bay, St. Louis Bay and St. Louis River to the limits of the cities of Duluth and Superior. These bays were once broad expanses of shallow water, averaging from 8 to 9 ft. in depth, except in the channel through them, and the original natural entrance was obstructed by shifting bars with 9 ft. of water. The works carried out by the U. S. government in past years have resulted in giving a good 16-ft. navigation through the natural or Wisconsin entrance; through the artificial Duluth Canal; over the Duluth Basin, of 104 acres; along and parallel to the dock lines of Duluth and Superior, and up the St. Louis River to New Duluth. The channels are well defined and are from 85 to 300 ft. in width. As before stated, however, commerce demanded deeper and wider channels, and a new project was authorized by Congress, on June 3, 1896, providing for the deepening of existing channels to 20 ft., the excavation of a new 20-ft. channel along Minnesota Point dock line, and for a general widening of channels and the creation of turning and anchorage basins 20 ft. deep. The project also includes the widening of the Duluth Canal, and replacing the piers of the Duluth Canal and Wisconsin entrance with substantial structures of timber and monolithic concrete. These plans demand an enormous amount of dredging, and contracts for dredging about 26,000,000 cu. yds. have been let, at an average of a trifle less than 8 cts. per cu. yd., to Williams, Green & Williams, of Duluth, Minn., and to Charles S. Barker, of Superior, Wis. This remarkably low price shows the economic value of the continuous contract system. The original estimate, based upon previous experience with intermittent appropriations, was 15 cts. per cu. yd. That the government is justified in making the expenditures necessary for the improvement of this port is shown by the fact that the lake commerce of Duluth and Superior amounted to over $112,000,000 in the navigation season of 1897; and since the United States took charge of this harbor this commerce has amounted to over $900,000,000.

The present descriptive matter and illustrations relate to the Duluth Canal entrance to Duluth harbor, and the plan given shows the location and general dimensions of the old and the new piers. This is probably the most interesting work included in the new project, from an engineering point of view, though somewhat similar work is to be performed at the Wisconsin entrance.

The contract has been let to King & Steele, for the construction of the substructure of the new south pier of the Duluth ship canal, through Minnesota Point, and a description of the work here proposed will answer practically for the whole improvement. We are indebted to the courtesy of Major Sears for the plans here used, and for the specifications relating to this work. These specifications show that the pier will consist of timber cribs, filled with stone and gravel, and resting upon piles cut off 22 ft. below low water datum. These cribs will be 24 and 36 ft. wide, with the tops extending to within one foot of datum, or low water; they will be built in sections of 50 and 100 ft. and the entire length of the south pier will be 1,722 ft. Resting upon these cribs will be a massive, concrete superstructure, generally 20 ft. wide at the base and extending to a height of 10 ft. above datum. The pierhead in the lake will be 36 ft. wide and 100 ft. long, and the channel face of the cribs will have an armor of 1-in. steel plate, to a depth of 7 ft. below the top, to protect the cribs from injury by vessels.

The character of the bottom material is clean sand, with a bed of gravel overlying the old Minnesota Point, about 13 ft. thick. A trench will first be dredged 26 ft. below datum and for the whole length of the pier, with a width sufficient to prevent any interference with the placing of the cribs. Piles, at least 9 ins. diameter at the small end, will be driven 4 ft. apart, on centers, longitudinally, and 4 and 5 ft. apart across the crib. Both the hammer and water-jet will be used in driving; and the final penetration will be 1 in. under the blow of a 2,000-lb. hammer falling 15 ft. The piles, when cut off, must be at least 17 ft. long, or penetrate the ground to a depth of 13 to 15 ft., thus making the pile about 43 ft. long before driving. A circular saw, mounted on a platform supported by the shoreward piles, will be employed in truly cutting off the piles 22 ft. below datum. The space between the heads of the piles will then be filled to within 6 ins. of the top of the piles with spawls and rock, not exceeding 1 cu. ft. in size, and gravel will be added to fill crevices and level the base to within a couple of inches of the tops of the piles. Protection piers, a pile dike and sheet piling along the trench slopes will be required for the protection of the work during its progress against lake storms, etc.

The pier cribs will be built as shown. The floor will be 8 ins. thick, laid close, with the under side flush; the timbers drift-bolted laterally, and alternate timbers secured by vertical machine bolts, 6 ft. long, passing up into the bulkheads. The channel side of the crib will be a double wall of 12 × 12-in. timbers; drift-bolted vertically, and machine-bolted horizontally. The rear side will be 12 ins. thick, and connecting these two walls will be transverse bulkheads, made of 10 × 12-in. timbers and, 4 ft. between centers, drift-bolted and with alternate sticks dovetailed into both walls. The cribs will be covered by 12 × 12-in. timbers near each side, and by 6 × 12-in. timbers for the remainder. Vertical posts, 10 × 10 ins., and 19 ft. 4 ins. long, will be bolted to the walls and bulk-

heads, as shown on the plan; and the timber to be used in these cribs will be white oak, for a certain number of courses near the top, and white pine or hemlock for the other parts. The pierhead cribs will be made stronger by the use of more oak, thicker bulkheads, double walls front and rear, and a double thickness of armor plate on the cutwater faces. All of these cribs are to be built in the harbor, towed into position and sunk by filling the pockets with rock and gravel in alternate 6-in. and 12-in. layers, commencing with the pierhead crib in the operation of sinking the piers and working towards the shore.

The pierhead crib, not shown here in detail, terminates in a cutwater having a central angle of 90° and sides about 25 ft. long, with the bulkheads arranged accordingly, and the whole crib strengthened throughout as outlined above. The cutwater will be faced with double 1-in. steel plates, for a height of 7 ft., riveted together and secured to the double timber wall by 1-in. machine-bolts with a counter sunk head in the plates. The under plate will return over the top of the upper timber, for a distance of 9 ins., and be bolted down by a 1-in. drift-bolt 24 ins. long and with counter-sunk head. The plates themselves will be generally about 8 ft. square, though these dimensions vary with positions.

At the ends of the several cribs the end bulkheads are 10 ins. back of the line of the floor, with four outside end-posts, as shown, bolted to the end bulkhead. Two sets of guide-stringers are built into the last two bulkheads, one set near the bottom and the other near the top of the crib. These 12 × 12-in. sticks project 9½ ins. beyond the line of the floor and are so spaced as to abut against the inside faces of the two middle guide posts on the opposing crib and serve as a guide in sinking. Before this space between two cribs is filled with ballast, a 4 × 6-in. timber, 19 ft. long, is run down to cover any space between the outside posts. This stick is secured in position by throwing in ballast against the bottom end and spiking the top. The pockets between the crib will then be completely filled with ballast. It is also specified that the last pocket in the crib is to be only half full of ballast before sinking to obviate any danger from the bulging of the ends before the cribs are in position.

The preliminary plans for the concrete superstructure, as designed by Major Sears, are shown herewith. This concrete work, with the exception of the footing blocks, will be built in place by depositing the concrete in molds forming sections of the full width of the pier and in lengths of 10 to 20 ft. The intention is to make each section as large as can be finished in one working day; and no layer of concrete will be allowed to set before the next is deposited and rammed. Four-sided molds will be used at first for alternate sections, and the intermediate sections will then be built with two-sided molds and a layer of tarred paper separating adjoining sections.

The footing blocks, 5 × 7 ft., and about 3 ft. high, will be molded on shore and then set close on the timber work to form the toe of the superstructure on each side of the crib. The only concrete deposited under water will thus be the limited space at the middle of the pier. American Portland cement will be used for these footing courses and natural cement for the remainder of the work. Beach gravel is abundant at the site of the work, and this will be used in the concrete and materially lessen the cost. A quantity of rubble stone will also be incorporated in the concrete, with suitable spaces between the stone, and the amount of concrete correspondingly lessened.

The steel plates on each crib are to be connected under water, after the cribs are sunk, by the use of straps 24 ins. wide, 8 ft. long and 1 in. thick. These plates will be secured in place by the "patch-bolts" shown. The strap will be punched and counter-sunk at the shop, and the drilling and tapping of the crib plates will be effected when they are in place by pneumatic tools operated by a diver. This arrangement will make a continuous line of well-connected 1-in. steel plates secured to the face of the cribs and reaching 8 ft. below low water datum. With a backing of 24 ins. of wall timber it is believed that these plates will efficiently protect the pier against all damage from ordinary collisions of vessels. In case two adjoining cribs do not exactly aline a special provision is made, as shown, for putting on the connecting straps.

A TEST OF THE HARDNESS OF CAST IRON.*

By Chas. A. Bauer, M. Am. Soc. M. E., Springfield, O.

Inasmuch as none of the previously known methods for determining the hardness of cast iron had proven to be practical, for a number of reasons, foremost among which was the impossibility of duplicating the results obtained, it became imperative that some method be devised that would be simple and yet reliable, and which would contain none of the objectionable features which are known to exist in other methods.

From the fact that a drill running at a uniform rate of speed and under a constant pressure, the number of revolutions which would be required to drill a given depth would be directly proportionate to the hardness of the material being tested, it was deemed expedient to formulate a method along these lines.

An ordinary drill press was equipped as follows: On the pinion shaft, which raises and lowers the spindle, is attached a disc 12 ins. in diameter, around the periphery of which is placed a light flexible wire cable, on the end of which is suspended a weight which maintains a constant pressure upon the drill. The standard drill is now placed in the chuck. The drill spindle has a revolution counter, and by means of magnets and an armature is controlled by the position of the drill in relation to the table. Adjustments are made so that the revolution counter is thrown into gear after the point of the drill is entirely embedded under the surface of the test piece, and out of gear when the spindle has descended from this point exactly one-half inch.

When the test is to be made the test bar is placed upon the table and the drill is brought down upon its surface; the feed lever is then unlatched. The drill is now rotated at a speed of 250 revolutions per minute, and the hole drilled. The revolution counter is electrically thrown into gear after the drill point is buried beneath the surface, and out of gear when the one-half inch from this point has been reached. The reading of the revolution counter now gives us the exact number of revolutions required to drill the one-half inch, and this we term the degrees of hardness. The more revolutions required, the harder the casting; slight variations in hardness being easily detected.

We have adopted, and would recommend as a standard, a ⅝-in. flat drill having an angle between its cutting edges of 120° and a clearance angle of 10°, running at a speed of about 250 revolutions per minute and having a constant pressure of 160 lbs.

The cutting angle may vary between 115° and 125° without affecting results, but the clearance angle should be 10°. The revolutions of the drill may vary between 240 and 260.

The pressure on the drill should be as near 160 pounds as possible in order to compare with results obtained elsewhere by this method, and should be determined while the drill is in motion. We have placed a small platform scale upon the drill table, then placed the test-piece on this scale and found the pressure to be 160 lbs. while making a test.

After the apparatus has been prepared and standardized, it is well to determine the hardness of a long test piece, which should then be put away and preserved as a standard. Any changes which may then take place can be entirely eliminated and results reduced to the standard by the formula,

$$\text{Degree of hardness} = \frac{Dr}{R},$$

in which D = the degrees of hardness of standard test piece; R = the number of revolutions of drill required to drill that piece under present condtions, and r = the number of revolutions obtained in drilling the piece, the hardness of which we wish to determine.

We make daily tests of our cast iron and mark each piece with its determined degree of hardness, and use any one of them to determine the change in the drill.

We have selected four test bars which represent four grades of hardness. Castings for our purpose should range between that determined for Bars Nos. 2 and 3; No. 1 would be considered too soft, while No. 4 would give us trouble in the machine shop and would surely bring in complaints. We repeated the hardness test on each bar, obtaining three results for each bar. We herewith submit results of these tests:

Bar.	Hardness.		
No. 1	130	128	129
No. 2	150	149	149
No. 3	170	168	167
No. 4	236	232	230

The greatest variation of results occurred in the drilling of the fourth bar, where it was less than 3%. We therefore believe that we have a reliable test and one that will prove of great practical value to all foundrymen.

*Condensed from a paper read at the Cincinnati meeting of the American Foundrymen's Association, June 7-10, 1898.

A NEW TYPE OF HIGH POTENTIAL INSULATOR.

The insulator shown herewith represents the latest type of a form of insulator developed to meet the requirements of long distance electric transmission. In the early days of low tension and short distances the usual form of glass or porcelain insulators were found quite satisfactory. With increasing pressure it was found that leakage began to be a considerable and dangerous item. This was partially remedied by increasing the number of petticoats, thus increasing the distance over which leakage currents must pass to reach the supporting pin, and at the same time affording more certain drainage during rainy weather. The next difficulty was experienced with puncturing, that is, current piercing the insulation. The natural remedy was to increase the thickness and vary the material. The resulting type of insulator, commonly known as the "Locke," after its inventor, may be described as two insulators,

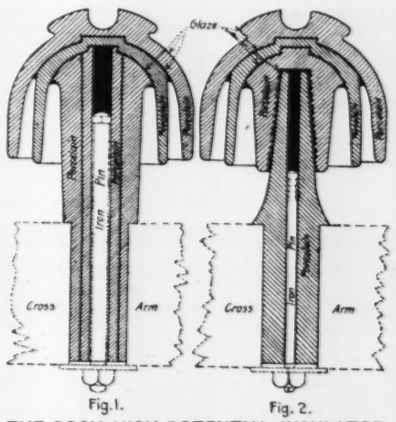


Fig. 1. Fig. 2.

THE BOCH HIGH POTENTIAL INSULATOR.
The R. Thomas & Sons Co., New York City.

one inside the other, held together by some cementing compound, such as sulphur. The insulator shown represents the latest type intended to obviate the difficulties mentioned. Like the "Locke," it consists of several pieces cemented together, the cementing material, however, being a glaze similar to that used in glazing porcelain ware. In this way the high insulating power of the glaze, which is considerably more than the semi-porous porcelain, is taken advantage of and, as will be seen in Figs. 1 and 2, six layers of glaze and two walls of glaze must be pierced before current can reach the iron pin R. Leakage from the petticoats to the pin is greatly reduced by making the pin also of porcelain. The method of manufacture of this insulator, as described in the patent (No. 601,195, March 22, 1898), is as follows:

The separately molded porcelain parts, after coming from the press, are dried separately, preferably in an oven or kiln, after the usual manner known as "biscuit firing"; when properly dried and ready for the vitrifying-kiln they are each coated with a glazing material, preferably all over, by dipping. The parts are then fitted together and turned upside down, i. e., drip edges up, forming a bowl into which the glazing liquid is poured until the space between the parts, represented by the black lines in the figure, is filled. The collection of parts is next carefully placed in the vitrifying-kiln and subjected to an intense heat, which melts the glaze and forms a solid, practically impenetrable layer or layers of the best kind of insulating material. The extra amount of glazing liquid prevents the formation of air spaces or cracks and fills all spaces resulting from a lack of correct fit or any shrinkage. Factory tests up to 60,000 volts have been made of this insulator with satisfactory results.

The insulators are manufactured, under patents granted to Mr. J. W. Boch, by the R. Thomas & Sons Co., 30 and 41 Cortlandt St., New York city.

THE COST OF BOILER ROOM LABOR.

A circular has been issued by the Mutual Boiler Insurance Co., 31 Milk St., Boston, Mass., for the information of its members, on "Cost of Boiler Room Labor." It is reprinted from a circular issued by the Steam Users' Association, Sept., 1896. Our readers may remember that the last-named

association was organized by Mr. Edward Atkinson, president of the Manufacturers' Mutual Fire Insurance Association, for the purpose of acquiring and distributing among its members information on subjects related to the economy of steam and of fuel. The association had a life of only one year, but its unfinished work has been taken up by the Mutual Boiler Insurance Co., of which Mr. Atkinson is also president and Mr. R. S. Hale, who was the expert of the Steam Users' Association, is Consulting Engineer.

The circular on "Cost of Boiler Room Labor" is an interesting compilation from statistics furnished by over 100 factories in New England, New York, New Jersey and Pennsylvania, giving particulars of their boiler plants, wages paid to firemen, kind and amount of coal used, etc. The statistics are studied and arranged so as to throw all the light possible on the subject, and some interesting conclusions are drawn from them by Mr. Hale. Some of these conclusions are as follows:

It takes no more hours of labor to fire a ton of hard coal than of soft coal.

Firemen in hard coal plants receive higher wages by 50 cts. to $1 a week.

The men fire more coal (about 15%) and receive more pay (about 10%) in the plants that run 24 hours a day instead of 10 hours a day.

The cost gradually decreases as the size of the plant increases, becoming, however, nearly stationary at 200 tons per week.

The labor per ton of coal is about 10% less for a steady load than for a variable load.

Handling coal should cost about 1.6 cts. per ton up to five yards, and then about 0.1-ct. per ton per yard for each additional yard.

Wages of firemen and work done per man are about the same in all the states named.

One man (besides night man) can run engine and fire up to about 10 tons per week. One man (besides engineer and night man) can fire up to about 35 tons per week; two men to about 55 tons, and three men to about 80 tons. These figures assume that the night man does all he can of the hoisting, cleaning and starting. These figures are for average conditions.

Mechanical stokers save 30 to 40% labor in very large plants, 20 to 30% in medium sized plants, and no labor in small plants.

The average figures obtained from 21 Eastern plants, using soft coal and running 10 hours a day are given below:

Plants using tons per week..	100 or over.	200 or over.	500 or over.	All plants.
Number of plants averaged..	8	2	1	21
Tons coal per man per week.	26	28	33	21.3
Wages of firemen per week..	$10.99	$11.62	$13.25	$10.92
Cts. pr ton, all labor boiler-rm	.42	.42	.40	.52

Effect of Variable Load.

Plants with load.....	Steady.	Varying w'kly or monthly	Varying hourly.
Tons per man per week...	23.6	20.3	23.6
Cts. per ton.....	50	46	61

The lower cost in the plant where the load varies weekly or monthly (such as cotton mills with water power) is explained by the fact that these plants pay the lowest wages.

Effect of Forcing Boilers.

Rate of burning	Quick.	Medium.	Slow.
Sq.ft. grate for 1 ton per wk.	Undr 1.51	1.51 to 3	Over 3
Tons per man per week....	33.8	22.8	20.1
Wages of firemen per week..	$13.25	$11.47	$10.52
Cts. per ton	.40	.50	.54

The decrease in cost per ton as the rate of burning increases is said to be probably because the number of men allowed to a plant is based on the work the boilers might be called on to do, and not on the work they actually do.

Effect of Rate of Wages on Work Done.

Wages, firemen pr w'k.	$10 and under.	$10-$11	$11-$12	$12-$13	Over $13
Tons per man per w'k	22.2	20.3	21.2	20.5	25.3
Cts. per ton.	45	48	55	61	57

These figures do not seem to sustain the oft-repeated paradox that the "highest priced labor is the cheapest labor."

In Mr. Atkinson's introduction to this circular he calls attention to the fact that the average cost of shoveling coal in all the establishments reporting is 48 cts. per ton, while in one establishment the cost is only 26 cts. per ton. He then shows what a fine large sum would be saved to the mill owners if the average of 48 cts. was reduced to 26 cts. in all establishments, and says: "Why should not 26 cts. be the standard or objective point in nine-tenths of the boiler rooms of the factories and workshops where suitable space can be provided?"

We can tell Mr. Atkinson several reasons why. The establishment which averages only 26 cts. per ton as the cost of shoveling coal, burns 1,000 tons a week, runs 24 hours a day, employs 32 men, and pays them only $9.50 per week. It is quixotic for Mr. Atkinson to urge that small concerns employing only one to three firemen can reach any such figure for the cost of boiler-room labor, unless this establishment which shows the lowest cost is being run on an extravagant basis. Furthermore, we may remind Mr. Atkinson that with coal at the price which it is at most New England mills, it doesn't take long for a fireman to throw his wages into the furnace door. If it is attempted to economize by employing cheaper men as firemen or forcing them to shovel more coal than they can handle and fire carefully and economically, the mill treasurer will be apt to find that he has been saving at the spigot. There is plenty of waste going on in many boiler-rooms, but it is not usually in the direction of either too high wages or too little work for the men who attend the furnaces.

A NEW CONTINUOUS RECORDING OR INTEGRATING ENGINE INDICATOR.

The ordinary method of determining the power developed by a steam engine, by means of an indicator, is far from being satisfactory. Indicator cards can be taken only at intervals, and it frequently happens that just before or after the card is taken a change in load occurs, thus making it imperative that a considerable number of cards be taken to secure anything like accurate results. The diagrams thus obtained must be integrated, necessitating a laborious operation with the planimeter. The need, therefore, for some form of instrument which can be readily attached to any steam engine, and which will as readily give accurate measurement of the power developed by that engine, is too well known to be dwelt upon.

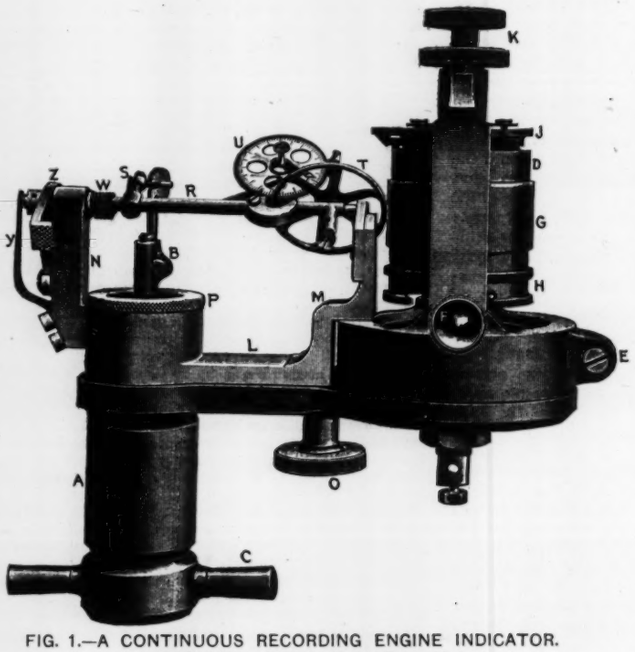


FIG. 1.—A CONTINUOUS RECORDING ENGINE INDICATOR.
W. G. Little, Bexley, Kent, Eng., Maker.

Many efforts have in the past been made to develop such an instrument, usually with small success, owing to the intricacy of the device or the delicacy of its parts. The instrument illustrated herewith is the latest and most successful of such attempts. It is the invention of Messrs. W. G. and C. W. G. Little, of Bexley, Kent, England, the former being at present the manufacturer of the indicator. Fig. 1 gives a fair general idea of its construction, showing also its simplicity. Briefly, the device can be best described by saying that the pencil movement of the ordinary indicator has been replaced by a planimeter wheel, rolling upon the drum as it is moved back and forth by the string attached to the crosshead in the usual way. This wheel is so connected to the indicator piston that as the pressure varies, the plane of the wheel is shifted relative to the axis of the drum.

Considering the parts separately, A is a steam cylinder containing the piston and spring, with the usual attachment screw coupling C and arm B. D is a drum provided with a coil drum, return spring enclosed in the split case, E; F is a removable stop for the drum, D; G is a metal sleeve slipped on D and capable of being slid up or down, should its surface become worn by the indicator wheel; H is the groove in which the operating string is wound; J K is an ingenious device for measuring the length of the drum movement, and is supported just above the drum. It consists of a central piece upon which are two flat rings, one provided with a graduated scale, and the other with a vernier. By turning the knurled head, K, the inner ring is turned around until the projection on the swinging drum strikes a projection on the lower side of the ring. The other knurled screw is then turned until the drum projection strikes a lug on the vernier at the other end of its travel, when the exact stroke can be read directly on the scale and vernier at J to 0.005-in.

The integrating mechanism is mounted upon a separate frame, L M N, which can be removed from the cylinder by unscrewing the cap P. It consists essentially of a main axle, R, intersecting the axis of the drum, with an offset lever, S, and a planimeter wheel, T, with its axis at right angles to R, and two counting disks, U. The wheel, T, is dished so that the point of contact between it and the drum is always in the center line of R.

The recording device, U, consists of two toothed wheels engaging in a worm on the shaft of the wheel, T. The upper disk has 100 and the lower 99 teeth; the upper counter thus gains one division for each complete revolution of the lower. In this way considerable time may elapse between readings, as the counter can record 10,000 revolutions of the planimeter wheel. Two pointers are used, one on the frame, indicating units and tens of revolutions of the planimeter wheel, and the other on the counter indicating hundreds of revolutions of the counter.

Two styles of instrument are made, one for high speed engines, that is, above 200 revolutions per minute, for which a 1-in. travel is provided; the other for low speeds, with a large drum intended for a 2-in. travel. The drum speed in either case is not supposed to exceed 50 ft. per minute, and may be easily calculated by using the formula, Drum stroke × 2 × revolutions of engine per minute = speed in ft. per minute.

At the end of the shaft, R, is a coilspring, W, which holds the pin of the lever, S, against the bottom face of the crosshead, X, which is attached to the end of the piston rod. Y is a spring bearing on the cone end of R, its duty being to press the planimeter wheel, T, against the drum. Z is a device for applying or withdrawing T to start or stop registering.

To operate the instrument it is screwed onto the indicator stop cock, such as is usually found at the end of the engine cylinder. Some form of reducing motion is attached to the crosshead and the cord is adjusted to obtain the proper swing of the drum. The indicator spring should never be less than 20% above the maximum pressure obtainable at the engine. In starting, both pointers must rest on zero to avoid mistakes in reading. After turning on steam and allowing the instrument to warm up, indications can be taken by throwing the release Z, and noting the time. To stop registering Z is raised and the steam valve closed, the time being again noted. The following formula is then used for calculating the horse-power developed:

$(D^2 \times L \times K \times S) \times B$ = horse-power, in which

D^2 = diameter of cylinder squared.

L = length of stroke of engine piston in ft.
K = constant of instrument =

$$0.000238 = \left(\frac{.7854}{33{,}000} \times 10\right).$$

S = scale of indicator spring.
s = stroke of drum in ins.
B = record on dial of instrument divided by the number of minutes run.

To obtain the mean effective pressure the formula

$$\frac{B}{\text{r. p. m.}} \times \frac{S \times 10}{s} = \text{M. E. P.}$$

is used.

This is based upon the fact that the dial record is always equal to one-tenth the area of a diagram which an ordinary indicator, with the same piston

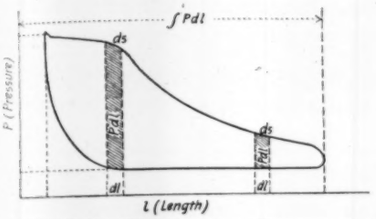


Fig. 2.—Indicator Diagram as a Measure of the Power Developed.

area, spring and a ratio of pencil to piston movement of 6 to 1, would give. To illustrate these formulae, assume an engine in which:

Diameter of piston = 6.5 ins. = D.
Length of stroke in ft. = .833 = L.
Scale of spring = 100 lbs. = S.
Instrument constant = 0.000238 = K.
Stroke of drum in ins. = 1.98 = s.
Record after 10 minutes = 90.

$$B = \frac{90}{10} = 9. \text{ for one minute, and}$$

$$6.5^2 \times .833 \times 0.000238 \times 100 = 0.837.$$

The record upon the dial is $\frac{1}{10}$ of an indicator diagram,

$$\frac{9}{1.98 \times 10} = 4.54,$$

and $.837 \times 4.54 = 3.799$ HP., or the power developed by the end of the engine cylinder to which the indicator was attached.

To determine the M. E. P. the dial is read for one minute, and the speed is taken for a like period. Assuming a speed of 212 revolutions per minute, and a reading of 9 on the dial for the same minute, then

$$\frac{B}{\text{r. p. m.}} = \frac{9}{212} = .0424$$

will be the record per revolution of the engine. The drum stroke is 1.98 ins., therefore, $\frac{.0424}{1.98}$ = .0214, gives a value which, if multiplied by 100 (the indicator scale), and 10 (since the record is $\frac{1}{10}$ of the real), we have $.0214 \times 100 \times 10 = 21.4$ lbs. as the equivalent pressure which, if allowed to act on each square inch of the piston for the full stroke, would produce the same total effect, hence the M. E. P.

The theory upon which the instrument is based, and a proof of its correctness, may be illustrated by first considering the familiar indicator card such as that shown in Fig. 2. This curve shows the pressure at any instant, and the time through which that pressure is acting. If, instead of the pencil which traced this curve, we should use a roller or wheel, and desire to read directly from the wheel the power developed, it is essential that the circumferential movement produced must represent, either direct or proportionally, the product of the pressure and the distance through which that pressure acts, or again referring to Fig. 2, for the instant (d s), s representing time, the pressure acting is P, and the distance (d l). The power expended during the instant (d s) then will be P d l, and during the full stroke it will be the summation of all these efforts between the limits of the stroke, or

$$\int P\,d\,l.$$

If this movement is direct the dial could read direct; if proportional, a proportional factor must be used to determine the real power. As this instrument is constructed the proportional factor is 0.1.

To show that the circumferential movement obtained is proportional to the actual power, it is convenient to imagine the drum surface developed into a plane, as in Fig. 3. A B represents the direction of the motion of the drum, C D its axis of rotation, E F the plane of the planimeter wheel, G H the axis of the wheel, and O its point of contact with the drum. Suppose O K equal to the small length (d l) of Fig. 2, and O I equal to (d s). If we now move the wheel from O to K in the time (d t) there will be certain amount of slip and a certain amount of true rolling. The sum will be equivalent to sliding the wheel from O to I, and rolling from I to K, during which movement I K would correspond to the circumferential movement. Referring to Fig. 3, I K = O K sin φ, or since $\varphi = \beta$, I K = O K sin β, or d l sin β = distance moved by a point on the rolling surface of the wheel in the time (d t). Sin β or sin $\varphi = \frac{P}{L}$ (see Fig. 4), that is, sin β is proportional to P, or the pressure, and as has been already shown, the wheel movement is directly proportional to d l sin β. Hence, it is proportional to P d l, and also $\int P\,d\,l$.

At first thought it would seem necessary to place the wheel, T (Fig. 1), perpendicular to the lever, S, but experience has shown that this is not the case, and as now constructed this angle is made about 35°, the object being to insure the necessary turning moment of the wheel at all angles apt to be encountered in working the instrument. In a series of careful experiments this angle of lead was also found to act as a compensating device balancing the small slip of the backward and forward motion in a most satisfactory manner.

Some experiments made by Prof. W. C. Unwin in 1895 gave excellent results, which compared very favorably with those obtained at the same time with a standard Crosby indicator. The early form has been improved until the instrument has now reached its present form, as shown in Fig. 1. Its accuracy is well shown in the following data, which represent comparative tests:

The first is a high speed test made at the works of Messrs. Willans & Robinson, Ltd., Rugby, Eng., on Dec. 22, 1897, using a standard Crosby

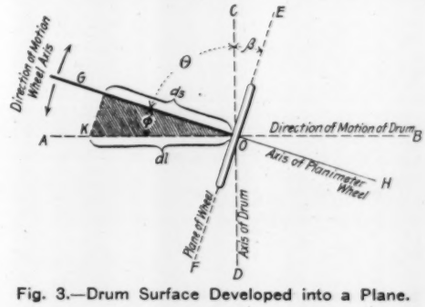


Fig. 3.—Drum Surface Developed into a Plane.

indicator and a Little integrating indicator. Both were attached at the same time to the low pressure cylinder of a large engine running at 350 revolutions per minute on a steady electric load kept constant by adjusting resistance in the circuit:

Crosby Indicator.

No.	Diagram, o'clock.	Planimeter. Start.	Planimeter. Stop.	Area.	Length.	Scale.	M. E. P.	Revolutions.
1.	4:12	0.0	0.91	0.91	2.1	50	21.67	350
2.	4:00	.91	1.83	.92	2.1	50	21.91	
3.	3:47	1.83	2.77	.94	2.1	50	22.38	

3 | 65.96

21.986

Crosby M. E. P. = 21.986 lbs.

Continuous Indicator.

Time, mins.	Reading, Total.	Reading, For 5 mins.	Reading, Per minute.	Stroke of drum, ins.	Scale.	M.E.P.
5	50.5	50.5	10.1	1.09	80	21.18
10	102.2	51.7	10.34	1.09	80	21.68
15	154.5	52.3	10.46	1.09	80	21.93
20	208.5	54.0	10 8	1.09	80	21.65
25	260.2	51.7	10.34	1.09	80	21.68
30	313.2	53.0	10.6	1.09	80	22 23
35	366.0	52.8	10.56	1.09	80	22.14

7 | 153.49

21.927

Little M. E. P. = 21.927 lbs.

The second test, a slow speed one, was made at Messrs. Vicars, Sons & Maxim's Works, Erith,

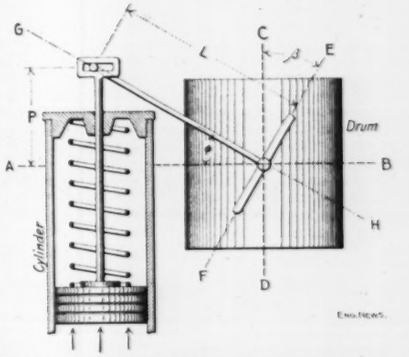


Fig. 4.—Diagram Illustrating Principle of Little's Indicator.

Eng., on Feb. 25, 1898, using a large simple condensing engine driving shop machinery, and is as follows:

Crosby Indicator.

No.	Diagram, o'clock.	Areas.	Length.	Scale.	M. E. P.
1	3:55	1.74	3.02	50	
2	4:00	1.87	3.00	50	
3	4:05	1.87	3.02	50	
4	4:10	1.70	3.02	50	
5	4:15	1.68	3.02	50	Average,
6	4:20	1.56	3.01	50	28.1215.
7	4:25	1.61	3.02	50	
8	4:30	1.81	3.02	50	
9	4:35	1.52	3.02	50	
10	4:40	1.62	3.04	50	

10 | 16.98 | 10 | 30.10

1.698 | 3.019

Crosby M. E. P. = 28.1215 lbs.

Continuous Indicator.

45 minutes' run: Total reading, 195.6; stroke of drum, 2.15 ins.; 100 spring; reading per minute, 4.3466; revolutions, 52.1.

$$\frac{4.3466 \times 100 \times 10}{2.95 \times 52.1} = 28.27.$$

Little M. E. P. = 28.27 lbs.

The instrument is for sale by W. G. Little, Bexley, Kent, England, the price being £14 10s. (about $72). We are indebted to Mr. Little for the material from which this description was prepared.

THE ENGINEER AS A USEFUL MEMBER OF SOCIETY.*

It is an all too common characteristic that the engineer is an engineer and nothing more. But this is not the stamp of engineer most needed, and therefore he is not fulfilling his greatest possible usefulness. The type of engineer I am advocating should be as follows: First, successful professionally; second, strong in business; third, influential socially.

Let us consider him along each of these lines. As a professional man he must necessarily be a well-trained man. This training may be the result of education or experience, or both. If he is consistent in his pursuit for it and is mentally endowed for it, he cannot but be strongminded. He must necessarily be a man of great application and concentration in whatever he undertakes. He is and must be honest. He does not hesitate to undertake the most unpromising tasks. He is, in brief, so constituted as to approach engineering tasks with indomitable courage and unfaltering assurance of success. He is cool-headed, slow to express a professional opinion, and, above all, a man who rarely asserts himself on subjects he knows little about. His course of study has been such as to make him essentially a man of clearly defined purpose. He counts not so much the financial as the mental profit in any undertaking. Thus far he is the engineer as he is publicly reputed to be, whether building vast edifices in our cities or opening up to civilization dense wildernesses.

Considering this ideal further, he should, as a business

*From an address by W. A. Layman, delivered at the commencement exercises at Rose Polytechnic Institute, June 16, 1898.

man, thoroughly understand the methods of the business world. He should know how commerce is conducted, the principles of banking, and how enterprises are organized and carried through. If there is any direction in which the average graduate from an engineering school is helpless, it is in that of understanding and being able to apply business principles. He is poorly qualified as a rule, even to the point of being able to protect himself. This partly arises from his concentration upon his preparatory engineering studies, and partly from his belief that engineering and commercial affairs are not in any sense kindred. He therefore enters upon his professional career pursuing purely engineering work. Subsequent opportunity rarely presents itself for him to acquire business experience, for the double reason that business men cannot entrust business affairs to inexperienced hands, and engineers who have attained some degree of professional reputation cannot afford to begin at the bottom of the commercial ladder. Quite too late for him to qualify himself, the average engineer begins to earnestly wish for a wider knowledge of business methods.

The ideal engineer will also play an influential part in social life. By social life I do not mean that existence eked out in so-called society circles. On the contrary, I mean social life in the broadest sense of fellowship with one's fellow men. The engineer so qualified will be interested in the political life of his immediate community, as well as that of the nation. He will study civil and criminal law to that extent which every good citizen is called upon to study it. He will contribute his share to the alleviation of distress, physical and political. He will mingle with his neighbors, studying to add to their comfort in and enjoyment of life. He will be a student of current affairs. He will make some study of literature. He will know what to read, and how to read and how to write. He will not necessarily be pre-eminent in social fields, but will be what is generally termed a well-informed and cultured man.

EXPERIMENTS UPON THE DURABILITY OF DIFFERENT METAL COATINGS IMMERSED IN SEA WATER.

In 1896 an interesting test was made at the Brooklyn Navy Yard to determine the relative durability of different protective coatings for metal when immersed in sea water. This test was conducted by Edward Smith & Co., of New York, under the personal direction of Prof. A. H. Sabin, Assoc. M. Am. Soc. C. E., of that firm, and with the permission and aid of the Navy Department. Briefly described the test consisted in covering thin plates of steel and aluminum with different protective coatings, placing these plates in cages and sinking the cages in about 6 ft. of water at the Navy Yard. The plates had an area of about 2 sq. ft. on each side and were so placed in the cages that both sides were fully exposed to the action of the water, which at this point is very foul with sewage and the collections of the harbor.

The cages were allowed to remain under water for six months and then were hauled out and an examination made of each. Altogether there were 84 plates. The results of this examination, the nature of the different coatings and other details of the test were published in a paper read before the American Society of Civil Engineers on Nov. 4, 1896, by Prof. Sabin. While this test led to a number of interesting conclusions, it showed the need also of further tests; and accordingly in the summer of 1897 another set of plates were immersed. This second set of plates was removed from the water on July 21, 1898, after an immersion of 13 months, in the presence of a number of engineers and visitors. The accompanying notes of the condition of these plates were taken by one of the editors of this journal, who was present, and examined them upon their removal from the water.

Altogether 133 plates were immersed in this second test. They were placed in six cages. Only two cages and half of a third could be recovered, however, and the accompanying table contains the result of the test of the 72 plates only, which these contained. An attempt will be made to dredge up the remaining plates for examination at some future date. Of the 72 plates recovered, twelve were plates which had undergone the 1896 tests and which were immersed a second time. These twelve plates were, therefore, immersed for 19 months altogether. The remaining 60 plates were new when immersed, and, as already stated, were under water for 13 months.

The different coatings with which the plates were covered are described in the table, and with a brief explanation these descriptions will be clear to nearly everyone. The ordinary oil and resin varnishes are made by compounding certain fossil resins with various proportions of refined linseed oil, and the essential differences in varnishes are due chiefly to the kinds of resin used and the proportion of oil. For convenience it is customary to assume 100 lbs. of resin as a unit. A 20-Kauri varnish, therefore, means a varnish resulting from compounding 20 gallons of oil with 100 lbs. of Kauri resin. A similar terminalogy is adopted for varnishes made of Zanzibar or Manila resin. Where the coating is described as "air dried" it is meant that is was allowed to dry onto the plate at ordinary temperature, and where it is described as "baked" it is meant that a heat of 215° to 240° F. was employed to bake the coating onto the plate.

In examining the plates they were simply removed from the cages, washed to remove the slime and loose marine growths, and inspected while wet. Only a few moments were given to the examination of each plate as it is intended to examine them more carefully when they have thoroughly dried. Until the results of this final study are collated it is, perhaps, best not to pass opinion upon the comparative behavior of the different coatings in detail. One or two broad conclusions, however, seem to follow from the facts given. It is pretty plain; (1) that whatever pigment is used, a more durable coating for marine work results if varnish is used as the vehicle than if oil is used; (2) that a varnish coating or a pigment and varnish coating seems to endure sea water better when baked on than when merely air dried on; (3) that white zinc is probably acted upon as little as any pigment which was used in the test, and (4) that enamel coatings baked on at high temperatures are apparently the most durable of any.

TABLE SHOWING RESULTS OF TESTS OF PROTECTIVE COATINGS APPLIED TO STEEL AND ALUMINUM PLATES IMMERSED FOR 13 MONTHS* IN SEA WATER AT BROOKLYN NAVY YARD.

No. of plate.	Character of vehicle.	Character of pigment.	Preparation.	Condition of plate and coating.
			Aluminum Plates.	
151	20 Kauri varnish	None.	Air dried.	Edges blistered; no considerable corrosion.
152	30 " "	"	"	Covering one-half gone; much corrosion.
153	40 " "	"	"	Covering mostly gone; badly corroded.
154	I X L No. 2 varnish	"	"	Covering half gone; not badly corroded.
155	Spar varnish	"	"	Covering mostly soft; some corrosion, not deep.
156	Spar varnish	"	"	Somewhat more corroded than plate 155.
157	"Durable metal coating".	"	"	Hard; no corrosion; 20% blistered at edges.
158	"Pipe coating" baked			Good condition.
159	"Pipe coating" baked			Good condition.
160	30 Kauri varnish	White zinc.	Air dried.	Quite hard; top, good condition; bottom, blistered.
161	40 " "	"	"	Good condition.
162	30 Zanzibar varnish	"	"	Excellent condition; no corrosion; no blisters.
163	Spar varnish	"	"	Several large blisters; not deeply corroded.
164	20 Kauri varnish	None.	"	Covering three-fourths gone; badly corroded.
165	30 " "	"	"	Covering badly destroyed; much corrosion.
166	40 " "	"	"	Covering considerably blistered; not much corrosion.
167	I X L No. 2 varnish	"	"	Covering considerably blistered; somewhat corroded.
168	Spar varnish	"	"	Coating soft; some blisters; not badly corroded.
169	"Durable metal coating".	"		Hard; considerably blistered; very little corrosion.
170	30 Kauri varnish	White zinc.	Air dried.	Hard; few blisters; some corrosion.
171	40 " "	"	"	Considerably blistered and corroded.
172	30 Zanzibar varnish	"	"	Hard; no corrosion; no blisters.
173	Spar varnish	"	"	Hard; no corrosion.
174	Pipe coating baked			Good condition; no corrosion; no blisters.
175	Pipe coating baked			Good condition.
...	Mitchell's	White enamel.		Excellent condition.
			Steel Plates.	
251	40 Kauri varnish	Ultramarine blue.	Air dried.	Many small blisters; little corrosion.
252	Raw oil	"	"	Coating practically gone; uniformly corroded.
253	20 Kauri varnish	Graphite.	"	Blistered slighhly; very little corrosion.
254	30 " "	"	"	Few small blisters; no corrosion.
255	40 " "	"	"	Many small blisters; no corrosion.
256	Raw oil	"	"	Coating destroyed.
257	20 Kauri varnish	Keystone.	"	Many pin-head blisters, but generally good.
258	30 " "	"	"	Pin head blisters; no corrosion.
259	40 Kauri varnish	"	"	Pin head blisters; no corrosion.
260	Raw oil	"	"	Coating destroyed; badly corroded.
261	20 Kauri varnish	Red iron oxide.	"	Blistered some; not badly corroded.
262	30 " "	"	"	Many small blisters; some corrosion.
263	40 " "	"	"	Many pin-head blisters; some corrosion.
264	Raw oil	"	"	Coating practically destroyed; badly rusted.
265	" "	Red lead.	"	" mostly gone; considerable corrosion.
267	" "	Prince's metallic.	"	" practically destroyed; badly rusted.
268	" "	Purple oxide.	"	" practically destroyed; badly rusted.
269	Eureka paint		"	" badly destroyed; badly rusted.
270	Detroit graphite paint		"	" destroyed; badly corroded.
272	Bowles' paint.		"	Good condition; few blisters.
273	Rahtjens paint		"	Coating badly gone; considerable corrosion; few barnacles.
274	McInnis paint		"	Very good condition; no barnacles.
275	International Holtzapfel		"	Coat'g badly gone; considerably corroded; sm'l barnacles.
277	Red lead and white zinc		"	Soft, gone in spots; corroded on edges.
278	Red lead and white zinc		"	Soft, gone in spots; corroded on edges.
281	20 Kauri varnish	None.	"	Discolored on edges by rust; not deeply rusted.
282	30 " "	"	"	Small blisters; not deeply corroded.
283	40 " "	"	"	Pin-head blisters; not deeply corroded.
284	30 manila varnish	"	"	Numerous small blisters; not deeply corroded.
285	30 Zanzibar varnish	"	"	Many pin-head blisters; little corrosion.
286	Spar varnish	"	"	Badly destroyed; considerable corrosion.
287	I X L No. 2 varnish	"	"	Many pin-head blisters; not much corrosion.
288	Raw oil	"	"	Coating destroyed; badly corroded.
289	Durable metal coating		"	Many small blisters; little corrosion.
			Steel Plates Reimmersed after 1896 Test.	
1	20 Kauri varnish	Flake white.	Air dried.	Rusted on edges; discolored; good condition otherwise.
2	20 " "	"	Baked.	Rusted on edges; discolored; good condition otherwise.
16	20 manila varnish	White zinc.	"	Some blisters; one side considerably corroded.
18	8 " "	Flake white.	"	Hard; pretty good condition.
20	30 Zanzibar varnish	White zinc.	"	No blisters; no corrosion.
22	20 Zanzibar varnish	"	"	Few blisters; some corrosion; hard.
35	Sabin Process pipe coating enamel			Some corrosion on one edge; otherwise good condition.
			Aluminum Plates Reimmersed after 1896 Test.	
113	Sabin Process pipe coating enamel			Two small blisters; otherwise good condition.
104	White zinc ground in varnish, one side baked			Three or four small blisters; otherwise good condition.
122	White zinc ground in varnish, one side baked			Three or four small blisters; otherwise good condition.
105	Chromium oxide ground in varnish, one side baked			Few small blisters; generally excellent condition.
124	Spar varnish, one side baked			Two or three small blisters; no considerable corrosion.

*The twelve plates from the 1896 test were immersed six months longer than the others, or nineteen months altogether.

THE CALHOUN PLACER MINING MACHINE.

The cheap and simple apparatus for placer mining and gravel washing, which is shown in the accompanying cut, is an adaptation to this particular work of the Calhoun excavating machine, which was illustrated and described in detail in our issue of April 15, 1897.

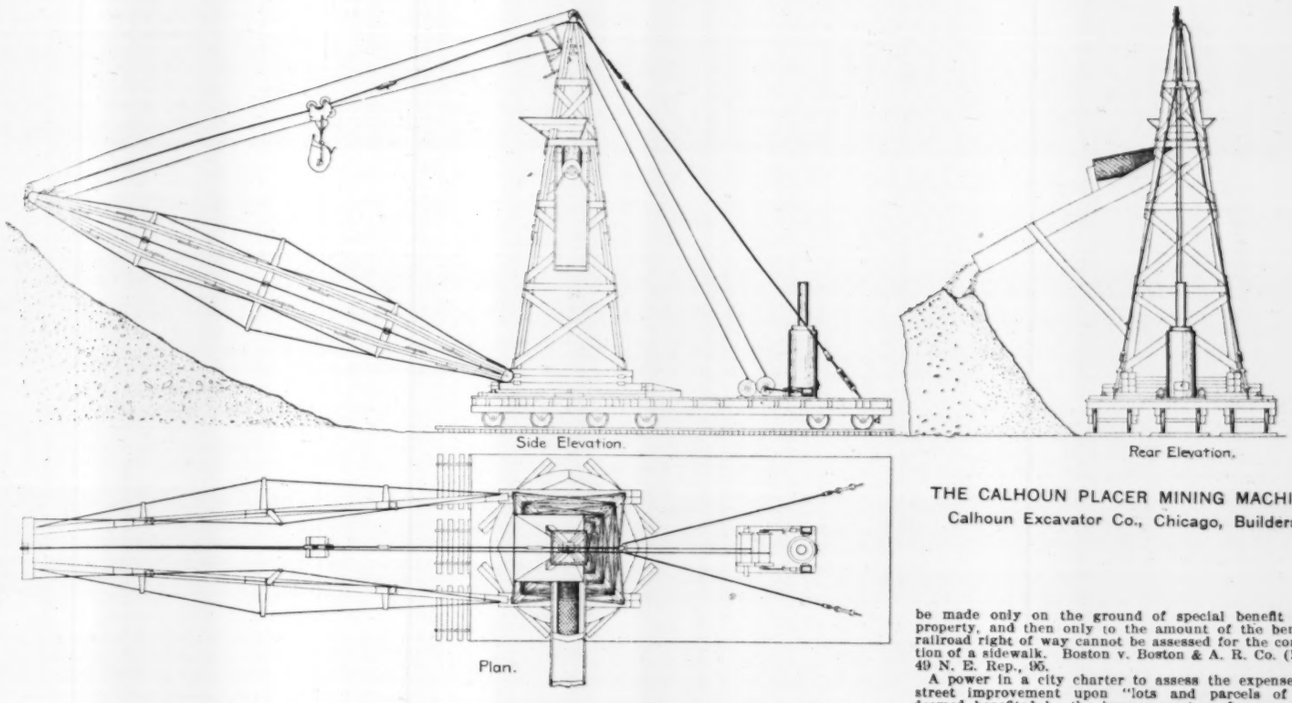
The machine is entirely self-contained, and consists of a tower, boom, hoisting plant and washing plant, all mounted on a large platform car running on three sets of tracks. The tower rests on a pivoted turntable, so that the boom can be swung to either side and make a cut sufficiently wide for the progress of the machine. At the rear of the car are placed the hoisting engine, pumps, etc. Near the front end of the car is the frame tower, about 50 ft. high, over the top of which pass the running, hauling and tail ropes. In this tower is a hopper, discharging into a revolving screen placed over an inclined chute. This chute has two floors, the upper one carrying the coarser material, which passes through the end of the screen, while the lower one forms the riffle box for retaining the gold carried down with the finer gravel, which passes through the meshes

of the screen. The lower floor can be made of sufficient width to admit of several partitions, thus giving a greater surface of riffles. A pump supplies a continuous stream of water to the hopper and the riffle box, and the debris is delivered clear of the cut and out of the way of the machine.

From the front side of the bottom of the tower extends a double boom about 70 ft. long, composed of two trussed members connected at their outer ends by a transverse timber, to which is attached the running rope, and on which are the sheaves for the tail rope. The running rope passes over the tower and has at its rear end a sheave, through which passes the back-stay cable, whose ends are attached by turnbuckles to anchors at the rear corners of the car. This arrangement permits of adjusting the slope or angle of the boom. The tail rope passes from the rear drum of the hoisting engine over the top of the tower, down to the end of the boom and back to the carriage, to which its end is attached. The hauling rope is also attached to the carriage, and passes under a sheave in the bail of the bucket, over a guide sheave in the carriage and back through the top of the tower to the front drum of the engine.

In the illustration the carriage is shown on its trip up with a loaded bucket. On reaching the tower the bucket is reversed and emptied by the tripping device, and is then started downward by the tail rope. When it reaches the detaching device on the hauling rope (which is placed just over the toe of the slope), the bucket is released from the carriage and drops vertically to the ground, where it automatically takes position for loading as it is pulled up the slope. Meanwhile, the carriage is pulled on down the running rope and is automatically locked by a latch at the end of the boom until the loaded bucket is again in place and locked to the carriage, when the catch is released. With proper handling, the bucket can make one trip per minute.

The machine may be built of wood, and has been designed for strength and durability under hard work and rough usage. Buckets of ½, 1 or 1½ cu. yds. capacity may be used. It is manufactured by the Calhoun Excavator Co., 628 Unity Building, Chicago, Ill., and further information will be furnished by the manufacturers on application. The California Wire Works, of San Francisco, Cal., have the agency of the Calhoun excavator for the Pacific Coast states, and will furnish information to interested parties in that territory.



THE CALHOUN PLACER MINING MACHINE.
Calhoun Excavator Co., Chicago, Builders.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Damage for Trolley Poles.

The poles and wires of an electric railway are an additional burden upon the street, not contemplated in the original dedication, made by a plat filed in accordance with law, and the abutting lot owners are entitled to whatever damages their property has sustained by reason of such location, especially where they interfere with his ingress and egress from his lots. Jayne v. Omaha St. Ry. Co. (Neb.), 74 N. W. Rep., 67.

Liability on Acceptance of Defective Work.

A contractor is entitled to recover from the other party who accepts the work and receives the benefit from it, although there was not a strict compliance with the special contract under which it was done, the contract price less such sum as will fully compensate the other party for the imperfections of the work or insufficiency of the materials. Smith v. Packard, 27 Southeastern Rep. 586.

Liability to Repair Pavement.

A contractor cannot avoid effect of provisions of his contract that he shall keep the pavements in good repair for a certain number of years, without cost or expense to the city, and that he shall assume the risk of damage to the work which may be occasioned by the caving in of the street, or from any other cause whatever, upon the ground that the caving rendering the repairs necessary was the result of the negligence of the city in filling such excavations before he did his work, and of which he had no notice. Warren-Scharf Pav. Co. v. St. Paul, 72 N. W. Rep. 711.

Railroads and Street Assessments.

Since assessments, under the laws of Massachusetts, can be made only on the ground of special benefit to the property, and then only to the amount of the benefit, a railroad right of way cannot be assessed for the construction of a sidewalk. Boston v. Boston & A. R. Co. (Mass.), 49 N. E. Rep., 95.

A power in a city charter to assess the expenses of a street improvement upon "lots and parcels of land" deemed benefited by the improvement confers no authority to assess on the tracks, ties, or franchises of a street railroad company. Conway v. Rochester, 49 N. Y. Supp. Rep., 489.

Liability for Flow from City Drains.

A municipal corporation which has increased the flow of water in a certain direction is only bound to exercise reasonable care in providing means for carrying off the surplus; it is not an insurer against unprecedented floods or cloud bursts. Keithsburg v. Simpson (Ill.), 70 Ill. App. Ct. Rep., 467.

A village by connecting its sewers, etc., with private drains, and draining the surface water of streets and sewers into same, becomes responsible for damage done by polluted water passing through them, to the same extent as it had originally connected such private drains, and is liable for the whole of the damage. Kewaunee v. Ladd, 68 Ill. App. Ct. Rep., 154.

WEATHER TABLE FOR JUNE, 1898. (Furnished to Engineering News by the Department of Agriculture.)

	Stations.	Temperature. (Degrees Fahrenheit.)				Wind.			Precipitation. Inches and hundredths.		
						Velocity in miles per hour.		Direction at time of max. velocity.			
		Average.	Max.	Min.	Range.	Average.	Max.		Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	62.4	86	36	50	7.6	36	SW	2.28	0.60	14
	Portland, Me.	61.3	89	45	44	6.9	24	S	3.98	1.13	15
	New York City	68.9	89	53	36	10.9	40	SW	1.28	0.30	9
	Pittsburg, Pa.	73.8	92	55	37	5 7	48	NW	3 98	1.35	10
	Chicago, Ill.	68.8	90	52	38	15.3	50	SW	5.30	2.50	10
	Omaha, Neb	73.9	95	55	40	7.6	28	SE	5.16	2.94	10
	St. Paul, Minn.	68.2	93	49	44	7.3	36	NW	2.71	0.90	12
	Duluth, Minn.	57.0	88	38	50	8.9	32	NE	3.52	0.97	12
	Bismarck, N. Dak.	64.4	95	40	55	10.7	40	NW	1.21	0.50	7
	Average.	66.5	91	47	44	9.0	37	—	3.27	1.24	11
Southern Cities.	Washington, D. C.	73.5	97	53	44	5.6	30	NW	1.33	0.80	5
	Louisville, Ky.	77 4	94	58	36	7.0	45	S	5.00	2.35	7
	St Louis, Mo.	77 8	92	61	31	7.7	37	SW	3.85	1.59	9
	Savannah, Ga	80 4	97	65	32	7.5	28	W	4.58	1.64	8
	Kansas City, Mo.	76 0	93	63	30	7.2	30	NW	6.05	1.73	14
	Jacksonville, Fla.	81.4	96	64	32	7.6	36	SW	2.13	0.85	8
	Chattanooga, Tenn.	78.1	97	59	38	5.8	40	SW	4.05	1.88	9
	New Orleans, La.	81.0	91	70	21	6.6	34	SE	3.79	1.18	11
	Memphis, Tenn.	79.6	92	65	27	7.7	52	W	2.76	.89	12
	Palestine, Tex.	78.6	93	64	29	5.7	28	S	5.50	1.81	18
	Average.	78.4	94	62	32	6.8	36	—	3.90	1.47	10
Western Cities.	Helena, Mont.	58.5	88	37	51	7.5	36	SW	3.52	1.14	14
	Port Angeles, Wash.	54.9	74	42	32	7.8	24	NW	1.24	0 43	10
	San Francisco, Cal.	59 0	89	49	40	13.1	40	W	0.19	0.18	2
	Salt Lake City, Utah.	67.1	96	33	63	6.6	37	NW	1.45	0.90	6
	Santa Fe, N. Mex.	64.2	91	41	50	6.1	30	SE	1.53	0.70	8
	Denver, Colo.	67 0	98	41	57	7.7	41	S	0.94	0.33	8
	Yuma, Ariz	—	—	—	—	—	—	—	—	—	—
	Average.	61.8	89	40	49	7.8	35	—	1.48	0.61	8

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Entered at the New York Post-Office as Second-Class Matter.

Published every Thursday

at St. Paul Building, 220 Broadway, New York, by

THE ENGINEERING NEWS PUBLISHING COMPANY

GEO. H. FROST, - - - - - - - - - PRESIDENT
D. McN. STAUFFER, - - - - - - - VICE-PRESIDENT
CHARLES WHITING BAKER, SECRETARY AND MANAGING EDITOR.
F. P. BURT, - - - TREASURER AND BUSINESS MANAGER.

WM. KENT, E. E. R. TRATMAN, M. N. BAKER, } ASSOCIATE
CHAS. S. HILL, J. J. SWANN, } EDITORS.

A. B. GILBERT, - - - - - - - ASSISTANT MANAGER

CHAS. W. REINHARDT, - - - - CHIEF DRAFTSMAN.

ALFRED E. KORNFELD, New York, } ADVERTISING
F. A. PECKHAM, Chicago, } REPRESENTATIVES
S. B. READ, Boston, }

PUBLICATION OFFICE, ST. PAUL BUILDING, NEW YORK.
CHICAGO OFFICE, 1636 MONADNOCK BLOCK.
BOSTON OFFICE, 299 DEVONSHIRE ST.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 months, $2.50; 2 months, $1.00. To all other countries in the Postal Union: Regular Edition, One Year, $7.60 (31 shillings); Thin Paper Edition, One Year, $6.31 (26 shillings). SINGLE COPIES of any number in current year, 15 cents.

Mailing addresses may be changed at will by sending both old and new address. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 328 means that subscription is paid to the 32d week (that is the issue of Aug. 11) of the year 1898; the change of these figures is the only receipt sent, unless by special request.

ADVERTISING RATES: 20 cents per line. Want notices, special rates, see page 18. Rates for standing advertisements sent on request. Changes in standing advertisements must be received by Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

Our readers who may be searching for amusement in these midsummer days, cannot do better than turn back to our issue of May 12, in which we reprinted the comments of "The Engineer," of London, on "Spain's Armored Cruisers." With the results of the Santiago engagement fresh in mind, it is highly entertaining to read the following:

> We find, therefore, that to all intents and purposes the Spanish "Vizcaya" class are battleships of the second class. * * * * The "Cristobal Colon" could and no doubt will "lie in the line" if there is a naval action; she is proof against every sort of shell. Except her and the "Pedro d'Aragon," now building, which carry 10-in. guns, all the Spanish armored cruisers carry a couple of 11-in. guns; very good pieces, able to penetrate all the armor on the American battleship's guns.
>
> The American armored cruisers are quite different; they are really armored cruisers. Their belts, instead of being 12-in. steel, as in the "Vizcaya's," are of 3-in. steel only; their big guns are only of 8-in. caliber. Now, an 8-in. projectile is quite useless against the belts of the "Vizcaya's," or against their barbettes, and in engaging such ships shell fire alone could be depended on to do anything. Of course, shell fire is the staple attack, but the "Brooklyn" and "New York" can do nothing against the Spaniards, with their comparatively feeble 8-in. shell, that the Spaniards cannot do against them with a far more powerful gun. It is rank heresy, maybe, but we cannot but hold that there is a tendency to unduly glorify the small quick-fire gun or the medium-sized 8-in. The chances of hitting are, of course, greater with the smaller weapon, both from its extra rapidity and its extra numerical quantity; but when the big shot does hit its effect will be, of course, far greater.

The latest news from Santiago is that the wrecks of the Spanish cruisers show eight 4-in., twenty 5-in., ten 8-in. and only two 12 or 13-in. shot holes above their present water lines. In view of this record "The Engineer" will probably modify its opinion as to the effectiveness of the 5-in. and 8-in. guns on the American vessels. The fitness of the "Colon" to "lie in the line" seems to be proved, but it is in line with the other wrecks on the Cuban coast and not in the line of battle.

The issue of "The Engineer" of July 8, contains some very unique comments upon the Santiago battle; its information has evidently been gathered from highly inaccurate sources, and its criticism is correspondingly wide of the mark. It betrays the most astonishment that the American vessels were so promptly got under way, when the Spanish cruisers appeared. "It is difficult to believe," it says, "that the American ships could have remained under full steam habitually, yet it is clear that they were so when the Spanish fleet came out. * * * * We must conclude, that if, as they say, they were taken by surprise, they were fortunate enough to have steam up for some other purpose."

Our contemporary is evidently a long way from comprehending the way they do things in the American navy. Upon the fleet before Santiago was placed the responsibility of preventing the escape of Cervera's cruisers. These were assumed to be ships of speed enough to escape from any of our battleships and power enough to defeat any of our other vessels. The sequel showed, indeed, that neither of these assumptions were true; and there were, of course, many reports before the battle as to the defective condition of the machinery and hulls of the Spanish vessels. The American commanders, however, would have been derelict in their duty had they allowed such reports to influence their action. Their business was to keep at all times sufficient vessels at the harbor entrance and ready for instant action to fight and destroy Cervera's fleet should it issue forth. To lie with fires banked and steam down, as the Spanish fleet did at Manila, would have been crass stupidity. It is safe to say that in all the weeks our vessels mounted guard off Santiago, there was never a time when furnace fires were not kept bright enough to keep up steam in the boilers, so that the ships could get under way at a moment's notice.

Other conjectures of "The Engineer" are hardly less amusing; but it caps the climax at the close with the following:

> The American fire was sufficiently well aimed to tell, while the whole of the Spanish fire seems to have been wasted. Even the Chinese at Yalu produced much greater effect with their unsuitable solid steel shot than the Spanish guns on this occasion. This suggests a ghastly possibility. Did the Spanish fire blank, owing to the absence of projectiles? Some shot they doubtless had; even the splashes prove this, but they may have been very few.

We have heard much from various sources as to the inefficiency of the Spanish navy; but "The Engineer's" conjecture that Cervera's fleet came across the Atlantic to take part in the war with its magazines chiefly supplied with blank cartridges is a little beyond belief. "The Engineer," we may remark, is in a chronic state of worry over shortness of ammunition. It is sure that Dewey's squadron has not enough left to bombard Manila with, and it has presented figures to prove that the American vessels at Santiago ought to have used up all their ammunition in fifteen minutes. But it apparently forgets that Cervera's vessels had never been in action at all until they came out of Santiago Bay to try and make their escape. If they ever had any ammunition, they had it then; and if they had nothing but blank cartridges they would have never taken the trouble to fire their guns.

Since the above was in type, "The Engineer," of July 15 has come to hand, in which we find further comments on the Santiago battle and more preposterous delusions as to the facts. Our contemporary still cherishes the idea that the American fleet maintained its blockade of Santiago with banked fires, and says it has now heard that "it had been apparent to the American ships that the Spanish ships were getting up steam and, consequently, they did the same." It then proceeds to draw with great gravity, as one of the lessons taught by the war, the following:

> To make a dash through a superior fleet, it is desirable to secure the lead in getting up steam.

Our contemporary's misinformation is by no means confined to this point, however. It is in a state of profound astonishment as to the "total disproportion in the effect of the American guns to that of the Spanish." In attempting to explain this, it seizes on a rumor that some of the principal guns had been removed from the Spanish ships, and declares that "this is too awful to call for comment."

From the same trustworthy informant, we presume, it has heard that the torpedoes on the Spanish vessels "seems to have lain on deck and formed mines for the enemy's shells to explode." On the basis of such cock-and-bull stories as these our contemporary adds the following gems to its list of "lessons taught by the war":

> A ship loses in fighting power if she omits to take her principal guns on board.
>
> Shots that only strike the water and make splashes produce no real effect on an enemy unless he is strangely nervous, consequently even quick fire is no use unless well directed.
>
> Torpedoes should not be left about exposed under a hot fire.

These and other "lessons" of similar profundity our contemporary propounds with the gravity befitting an original discoverer of great truths. It is to be hoped that the folly of "only striking the water and making splashes in the hope of producing an effect upon the enemy" will be appreciated in future by all naval commanders. To quote again our highly entertaining contemporary:

> Nay, apparently, had they fired a quantity of blank cartridges which made a thick smoke they would have done the Americans nearly as much harm as they did and perhaps made it more difficult to deliver a well-aimed fire at them.

After this we can only congratulate ourselves that the author of these novel naval tactics was not in command of the Spanish fleet.

The New York Canal traffic thus far this season has fallen far below even the low record of last year. The total to July 16 is but 5,453,000 bushels, against 7,238,000 bushels in the same time last year. The poor showing is ascribed to the numerous breaks in the canal, which have delayed the boats, and to the opening of the canals a week later than usual. On the other hand, the total grain receipts at New York since May 1 have been more than 7,000,000 bushels larger than last year; and the elevator pool at Buffalo, which has for so many years been denounced as the chief enemy of the canals, has been broken. Instead of the old standard rate of ⅞-ct. per bushel for elevating grain at Buffalo, the rate this year has dropped as low as ⅛-ct. The railways, however, also have the benefit of the lower elevator charge, and it is said that they are now transferring grain from Lake steamers to cars at Buffalo in some cases without charge. Another notable fact is that nearly all the canal grain traffic has been in corn and oats. Only 16,000 bushels of wheat have been shipped by canal up to date this season, while the railways have brought to New York nearly 17,000,000 bushels. Apparently, in the rapid fluctuations of the market the slightly cheaper rate on the canal has cut no figure in comparison with the greater dispatch of the railway. The grain shipper had rather pay two or three cents more a bushel than run the risk of a drop in price of three or four times that amount. In view of the fact that since the canals opened the railways have carried seven-eighths of the grain traffic, and that the total amount of grain coming to New York has increased at the same time that the canal traffic has fallen off, those who urge the maintenance of the canals as essential to New York's supremacy in the export trade may find it necessary to revise their opinions.

A test of the Ellithorpe air cushion for elevators was made in the new Empire Building, Broadway and Rector St., New York city, on July 18. The building is 20 stories high. The air cushion is formed by making that portion of the elevator shaft from the basement to the level of the third floor an enclosed well, with sides of riveted steel plates and steel doors which are enclosed in strong frames in such a manner as to prevent their being blown out by the air pressure which would be developed by the sudden descent of a car. The test was made by suspending by a short rope from the bottom of the regular elevator car, another car, an old one, weighing about 2,000 lbs. This was raised to the top of the shaft, the rope was cut and it fell. On the floor of the old elevator were arranged a dozen eggs, four glasses of water, and the globe of an incandescent lamp, with the idea, says a press report of the test, that if they passed through the ordeal a man could safely do so. A preliminary test was made by dropping the car from the 10th story. The eggs and the lamp globe remained unbroken, and only a few drops of water were spilled. Then the test was made by dropping the car from the 20th story. The report states that its velocity when it passed the third

floor was 126 ft. per second, nearly 1½ miles a minute. This corresponds to a free fall of 250 ft. It also says that the second test was considered just as satisfactory as the first, "although the frail woodwork at the back of the car was wrenched out of place, the eggs remained unbroken." Nothing is said about the glasses of water and the incandescent lamp in this test.

The idea that if an egg could pass through this "ordeal" a man could, appears to us a little doubtful. Consider a man weighing 160 lbs. standing on the floor of an elevator car falling at the rate of 126 ft. per second, which would be its speed at the end of a free fall of 250 ft. The energy of the descending man would be $160 \times 250 = 40{,}000$ ft.-lbs., and this amount of energy would have to be absorbed before he could be brought to rest. Suppose his speed were checked at a perfectly uniform rate so that he would come to rest at the end of a further descent of 50 ft. If the man remained in an upright position the pressure he would bring on the floor of the car, and the reaction of the car on the soles of his feet would be $40{,}000 \div 50 = 800$ lbs. That is, during the whole time during which the descent of 50 ft. lasted, the man would practically weigh 800 lbs. If during a portion of this time the rate of reduction of speed should be greater, the pressure of the man on the floor of the car would also be much greater. The chances are that the man would not remain in a vertical position. He would be likely to bend his knees with such suddenness as to fracture his knee-caps, and if his weight were then taken on his hands his arms would be broken, or if not he would experience a probably fatal concussion of the brain or of the spine. It may be said that all this is theory, however, and the practical test shows that the eggs were not crushed. But why should they be? We have made a little experiment with eggs, and here are the results: Three eggs weighed together 5½ oz. They were put on a small plate, and another plate was placed above them, making a platform on which was piled a weight of 13 lbs. before the eggs were crushed. That is, an egg subjected to a crushing force between two plates resists a pressure equal to about 38 times its own weight.

When a falling elevator car is gradually checked by an air cushion, the effect upon an egg in the car is to increase its pressure upon its support, just as in the case of the man. But the rough test which we have cited above seems to indicate that the egg could be subjected to a retarding force equal to 38 times its own weight before its shell would crush. A 150-lb. man under such a force would have a pressure of no less than 5,700 lbs. on the soles of his shoes, if he could continue to stand erect, which would be, of course, impossible.

Of course we are supposing in each case the retarding force to be applied without shock, for a very trifling shock would crush the egg, while the man has elasticity enough in his anatomy to absorb without injury the shock from a free fall of several feet. When it comes to a fall of ten or twenty stories the air cushion test simply proves that eggs are stronger than they are generally supposed to be, but it proves nothing, so far as we can see, as to what would happen to a man in an elevator car under the same conditions of fall.

THE VALUE OF HIGH SHORT-TIME TENSILE STRENGTH TESTS FOR HYDRAULIC CEMENTS.

Quite a large number of cement specifications published recently have challenged comment on account of the enormous tensile strengths which they require both natural and Portland cements to develop in one, seven and twenty-eight day tests. In certain instances which have come to our notice the tensile strength requirements of the specification ran as high as 175 lbs., 500 lbs. and 600 lbs. for Portland cement at these respective ages, or from 30 per cent. to 40 per cent. higher than engineers usually require for the same classes of work. Figures for natural cement when compared run much the same way.

It is a legitimate question, we think, whether such very high tensile strength requirements are desirable. Certainly the question may be raised whether in the ordinary run of engineering work there is any good reason for such differences in practice as the figures just quoted show. It must be either that too low requirements are being demanded by engineers generally, or else that in these exceptional cases a value is being set on very high short time tests which is largely fictitious, and it should be determined which case is really the true one. The necessity for making such an investigation is increased by the fact that these high-test specifications have been made the subject of such extended mention in engineering papers and elsewhere that they are being accepted without question by many persons as being a generally recognized improvement in engineering practice. Time may, indeed, show this to be the case, but at present their position in this respect is not unassailable, and it may be beneficial to some of our readers who have not studied the question to point out the possible objections to these very high short time cement tests.

The first thought that comes to one is that we have the irrefutable evidence of hundreds of structures built with mortars and concretes made from the low strength cements and hydraulic limes of a half century ago that such cements in most cases retain their durability and develop strengths which are adequate to all demands. The rock-like consistency and hardness of some of this early cement work has indeed often been the subject of special remark by engineers who have had occasion to examine it. Most of these cements probably would not have withstood the short time tensile test demanded of natural rock cements to-day, and they certainly would have failed to give even approximately the high strengths demanded of Portland cement at early ages by the figures just quoted. It may be argued, of course, that if these low strength cements have proved so efficient, the high strength cements of to-day will be proportionately better, but this is not necessarily a correct deduction, as will be shown a little further on.

Meanwhile it may be pointed out that apparently the opinion is exceptional, rather than general among engineers that such very high short time strengths are desirable. The current American and European specifications for Portland cement which are published elsewhere in this issue bring out this fact very clearly, as a brief glance at the accompanying summary of the more detailed figures will show:

	Tensile strength in lbs. per sq. in.				
	Neat cement.			3 sand 1 cement.	
Specifications.	1 day.	7 days.	28 days.	7 days.	28 days.
European governm't.	None.	347	528	119	204
U. S. government..	114	394	536	129	190
91 misc. American.	134	384	528	118	180
General average ...	124	375	531	122	197
Philadelphia, Pa. ...	175	500	600	170	240

To emphasize the difference between average practice, as shown by these figures, and the exceptionally high test requirements referred to, the figures of tensile strength required of Portland cement in public works in the city of Philadelphia, Pa., are appended to the table in shape for direct comparison. As we have previously stated, these requirements are the most severe of which we know. Even the specifications for the U. S. Government lighthouse work are not higher, and there, if in any class of engineering work, it would seem that great strengths at early ages might reasonably be demanded of the cements which are used.

The figures in the table can be compared by each person for himself. All that it is necessary to remark here is that the superior advantages of the highest at least of these short time tensile strength requirements for cements are not recognized by the actual practice of engineers who have in charge the most important works in which cements are employed. The inference is at least fair, then, that such high strengths at early ages are of doubtful value in practical construction. Leaving the question of prevailing practice out of the argument, however, let us inquire what the advantages of unusual strengths at early ages are likely to be in the light of the duties which cement is ordinarily called upon to perform.

It is fair to say, we think, that nothing like the full ultimate strength of a cement is required at such early ages as one week or even four weeks in by far the greater number of places where this material is used. In lighthouse work, or in breakwaters, jetties and similar marine constructions exposed to the fury of the waves, it may be desirable for the masonry to develop its full strength at a very early age, but in the majority of engineering works this is not true. The quality which the engineer really wants most is that the cement shall develop a fair strength in one week or in four weeks and shall gradually increase this strength and maintain it as long as the structure may be called upon to endure. In other words, the whole matter simmers down to the question of durability.

The inquiry then comes up whether cements which show unusual strengths at early ages are any more durable than others. Cement literature, so far as we know, contains nothing to show that they are. There are several things, however, which tend to show the contrary. It is very commonly remarked by those who have made long tests of Portland cements that those cements which showed exceptionally great strengths at early ages were far more likely to become brittle with age than those which tested lower at first. This is exactly what we should expect from our knowledge of rock crystalization. In rocks it is well known that the more rapid the hardening the more imperfect and uneven in shape, size and texture are the crystals until they finally disappear altogether and the material comes out glass instead of stone.

Unfortunately, exact figures are largely lacking upon this feature of the hardening of cements, but some suggestive tests which bear indirectly upon it were published by Mr. R. E. Middleton, M. Inst. C. E., in London "Engineering," of April 6, 1888, which are worth quoting in lack of more comprehensive proof. Mr. Middleton's figures are as follows:

No. of test.	Age, days.	Strength, lbs.	Age, days.	Strength, lbs.	Age, days.	Strength, lbs.	P. c. gain or loss.
1.	7	258	942	440	1,325	550	+ 113
2.	7	320	900	635	1,283	577	+ 75
3.	7	371	982	560	1,395	599	+ 61
4.	7	419	1,040	435	1,423	492	+ 18
5.	7	479	1,088	542	1,471	551	+ 15
6.	7	534	858	545	1,241	526	— 1.5

These figures apparently show that cements which test from 250 lbs. to 350 lbs. in seven days increase in strength more and retain their strength better than do cements which test from 400 lbs. to 600 lbs. at the same age. It would be manifestly improper to conclude from these figures alone that the same result would always follow, but they are rather significant when taken in connection with other evidence.

But even supposing that cements which show a strength of from 500 lbs. to 600 lbs. in seven-day tests do not deteriorate in any way, what particular advantage follows their employment? The case is evidently not like the case where structural steel, for example, is the material employed. If by some new metallurgical process we increase the efficiency of a steel bar to do work we at once reap a direct gain in the reduction in size and weight of the members which we must put into our structures. It is not so in using a cement which tests 50 lbs. or 100 lbs. more than others. The conditions of its employment in the great majority of engineering works are such that very little if any reduction is possible in the amount of material which must be used whatever its strength may be.

There is another phase of the matter also which may be enlarged upon in this connection. It costs more for the manufacturers to produce a cement which will test 500 lbs. in seven days than it does to produce one which will test 300 lbs. at that age. Unless a proportionate advantage is gained by reducing the quantity and weight of the cement employed or by an increase in its durability, in using the high-testing material, therefore, this extra cost is a waste of money. Furthermore, as many cements cannot be made to develop such great strength by normal means, manufacturers, in order to meet the high test requirements demanded, use adulterants, which are always useless and may be exceedingly detrimental to the final strength and durability of the cement. So common had this practice of adulteration become in Germany a few years ago that both the manufacturers and the government authorities were compelled to adopt stringent measures to put a stop to it. We have here evidence that the demand for very high tensile strengths at early ages, while intended to

guarantee an especially good material, really results in an inferior one being put on the market.

These, then, are some of the reasons why we may, perhaps, conclude that the excessively high tensile strength requirements which some specifications contain are not warranted by the advantages which the cement that meets them offers for practical engineering work. Lacking conclusive proof that cements which are very strong at early ages are not more durable than those which test lower, this is probably all that we are justified in concluding. There is great need for definite experimental information upon this point in the shape of a series of long time tests of various cements having very low, very high and medium strengths in short time tests. Such tests if sufficiently comprehensive would do very much to settle the question which we have briefly discussed here, and some of our cement laboratories would perform a valuable service to engineers in carrying them out. Unless such enormous strengths as 500 lbs. or 600 lbs. in seven days give correspondingly greater durability and strength, when the cement has been in place for years, they place a useless expense upon both makers and users of cement and should be abandoned in drawing cement specifications for the ordinary run of engineering work at least.

In conclusion we should not be understood as trying to discourage any legitimate attempt upon the part of engineers to secure better qualities of hydraulic cements. We do think, however, that there is a tendency evident in many instances to place too high a value upon tensile strength as the criterion by which a cement should stand or fall as a proper structural material to be used in engineering works, and that this tendency is leading some engineers to make mistakes in formulating their cement specifications. If the same effort which has been expended by engineers and manufacturers to increase the tensile strength of cements at early ages had been expended in developing their reliability and durability the benefit would have been much greater.

LETTERS TO THE EDITOR.

The Patents on the Diesel Motor.

Sir: In your issue of July 21 you give a short abstract of a paper read by Mr. E. Capitaine at Frankfort, attacking the Diesel patent. Having given Mr. Capitaine's statement, you will, no doubt, in fairness, give also Mr. Diesel's reply.

Mr. Diesel advises us that Mr. Capitaine's paper was read in Frankfort on the 20th of April, and consisted mainly of statements and data, which Capitaine had submitted in his suit before the Imperial German Patent Court. In this he moved to annul or largely restrict the Diesel master patent. On the very next day, April 21, 1898, the court, after a review of all this testimony, denied his motion, upheld the Diesel patent and condemned Capitaine to pay the costs. An official copy of this action of the Imperial German Patent Court is on file here and will be gladly shown to any one sufficiently interested in the matter.

Very truly yours,
Diesel Motor Co., of America,
E. D. Meier, Engineer-in-Chief.
11 Broadway, New York, July 25, 1898.

Frog Angles and Crossing Frogs.

Sir: I desire to present some discussion upon the letters on frog angles and crossing frog formulas, published in your issue of June 16. The two points I wish to cover, are, 1st, the useless multiplication of formulas when the case is already fully covered by the standard formulas given for right angled or oblique triangles; and, 2d, I wish to challenge the idea that it is possible to construct a desirable crossing by measuring any part of an old one that is ready to be renewed.

I would like first to call your attention to what seems to me to be the unnecessary complication of the formulas given in Mr. R. S. Ball's method. Would it not be much plainer to say that all cases where a curved track crosses a straight one, with the angle of intersection and the radius of curvature given, can be reduced to a simple case of right-angled triangle, which does not need any other formula than those already given in any pocket manual. Thus, taking the accompanying diagram, the basic factor is the triangle E, F, G, of which G is the point of intersection, F is the center of curvature, and E the point where a line from the center of curvature strikes the center line of the straight track at right angles thereto. You thus have a right-angle triangle with the hypothenuse and one of the acute angles given from which

$F E = r \cos \theta$, adding $\frac{1}{2} g = Fe_1$, substracting the same $= Fe$.

$F A$ and $F C = r - \frac{1}{2} g_1$.

$F B$ and $F C = r + \frac{1}{2} g_1$.

Then, with those two side of the respective triangles given we have

$$\cos A = \frac{Fe_1}{F A}; \cos B = \frac{Fe_1}{F B}; \cos C = \frac{Fe}{F C}; \cos D \frac{Fe}{F D}.$$

The actual work will be the looking up of four logarithms, the finding of their differences as indicated, and then searching in the tables for four angles.

Then for the sides,

$$\left.\begin{array}{l} e_1 A = Fe_1 \tan. A \\ e_1 B = Fe_1 \tan. B \end{array}\right\} A B = e_1 B - e_1 A.$$

$$\left.\begin{array}{l} e C = Fe \tan. C \\ e D = Fe \tan. D \end{array}\right\} C D = e D - e C.$$

Angle $A F C = C - A$, of which the tabular arc $\times F A =$ side A C.

Angle $B F D = D - B$, of which the tabular arc $\times F B =$ side B D.

This seems to be much more desirable than a long formula that simply amounts to the same thing.

Mr. Wm. Wallace Christie gives methods of solving crossing problems, which seem to me to be specially open to the criticism of starting with an unnecessarily erroneous basis.

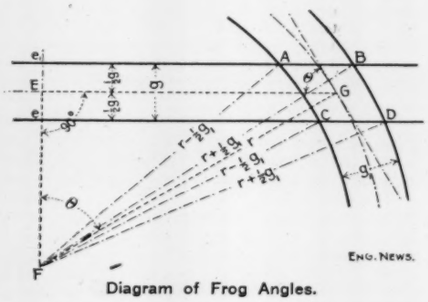


Diagram of Frog Angles.

My experience leads me to believe that it is utterly impossible to secure satisfactory data in the way he describes, namely, by measuring the diagonal of an old crossing and getting the curvature by ordinates. I can hardly conceive of a case where it would be impossible to run out the curves and get the correct angle of intersection, and the better result would most certainly pay for the cost of sending out two men to secure such data, in fact the case would be a rare one where it would cost much (if any) more to get the correct angle than to get the meager information he uses.

Having got the angles of intersection, his Case 1 then becomes the simple solution of right-angled triangles which I have already described, and his Case 2 becomes the solution of a series of oblique triangles whose common side is the line joining the centers of the two curves, the other sides being respectively R and $R_1 \pm \frac{1}{2}$ the gage, according to the point sought. Any formulas that might be needed are surely to be found in the standard formulas given in any of the pocket manuals for these two classes of triangles.

Yours truly,
E. D. Wileman,
Lake Shore & Michigan Southern Ry.
Toledo, O., June 25, 1898.

The Report on the Condition of the Paints on the 155th Street Viaduct, New York City.

Sir: Your editorial of July 21 upon the report on the condition of paints on the 155th St. viaduct shows a lack of ability to grasp either the scope of the report or the character of the tests which is deplorable. Even while you quote from the report the statement that these percentages were carefully reviewed, "so that they might correctly represent the comparative condition of each girder," your criticism is based upon the fact that they do not represent absolute values. Does any intelligent engineer ever make a railroad profile to the natural scale? Yet the elevations are directly comparative.

The purpose in describing in such detail the method of examination was to enable any engineer to make his own deductions; and it was not expected that a test of six months' duration would be considered final or conclusive. You suggest the advisability of waiting two years before forming any conclusions. You seem to be unaware that this structure is liable to be repainted at any time, since the original invitation of May, 1897, from the Department of Public Works, made reference to "painting the vialuct next year." It is to be hoped that this repainting may be deferred, but we have no assurance that such will be the case. Although the test is of such short duration, there are two facts which are as definite now as they ever will be:

1. A number of the paints have failed absolutely to protect the metal from sulphur gases.

2. The carbon and graphite paints prove generally efficient for this purpose.

You suggest that "it would be an excellent idea for the Committee of the American Society of Civil Engineers, which has in charge the subject of paints on metal work, to make a thorough examination and report." Would it not be a still better idea first to appoint such a committee, as none exists at the present time? Furthermore, there is no probability that a committee of the Am. Soc. C. E. could ever make such a report. Neither red lead nor iron oxide in pure linseed oil have been tested here, yet these two paints have long been in general favor as a protection for iron. All the paints used in this test were patented compounds.

Your criticism of my method of giving percentages may be left to the individual judgment of your readers. If a girder 69 ft. long and 9 ft. deep cannot receive a general inspection from a point 12 ft. distant, the results sought are not such as should be desired in a report of this character. You may find difficulty in counting the rust pimples on a girder, but for the purpose of a report of progress you may select several points of view, each equally advantageous for every girder, make a separate list of percentages from each standpoint, and by computing the averages obtain results which are fairly accurate and truly comparative. While it may be true that no two engineers would give exactly the same percentages, it is also true that engineers following this method of procedure would not differ materially on the comparative condition of these paints.

Your editorial quoted the paragraph describing the method of procedure. Why not quote the next paragraph as follows:

After completing the examination and recording the results, the kinds of paints used for each girder with the number of coats and comparative rapidity of drying were obtained from Mr. M. E. Evans, C. E., under whose direct supervision the girders were cleaned and the various paints applied.

This is the key to the whole report. The stipulation with which I undertook this examination, was that I should have no previous knowledge of the different kinds of paints on the several girders. Did your examining editors take the same precaution?

I regret that any of your advertisers should have been injured by your publication of the report.

Yours truly,
Henry B. Seaman.
40 Wall St., New York city, July 25, 1898.

(Mr. Seaman's statement in his original report was that the figures he gave represented the percentage of the surface of each girder which was free from rust. We took this to mean that they were intended to represent absolute values; but the first paragraph of the above letter seems to contradict this.

We were in error in supposing that the committee of the Am. Soc. C. E. on "Paints for Metal Work" had already been appointed. A resolution favoring the appointment of such a committee was adopted at the annual meeting last January, and was referred to the Board of Direction in accordance with the Constitution. The Board will report its action on the matter, we suppose, to the meeting at Detroit this week.—Ed.)

Gould's "Arithmetic of the Steam Engine."

Sir: I have just read your review of my little book, "Arithmetic of the Steam Engine," in the June 2 number of Engineering News, having missed many numbers during my absence at army headquarters in the South. Since you therein charge me with several errors and inaccuracies I presume that you will allow me to attempt to clear myself of these charges.

Let me first say I am glad that one of the charges which you make against my book is its brevity, because I consider that to be one of its chief merits. It would fail utterly of its purpose if it were not brief. But to turn to the more serious faults which you allege against it.

You say my assertion that the quantity or heat contained in a body is "its temperature into its weight into its specifit heat," is incorrect because it does not apply to superheated steam. I think this criticism is hardly fair, especially since I state, in the chapter on steam, what the quantity of heat contained in steam is.

You next take exception to my statement that, per Porter's tables, the sensible heat of steam is always a little higher than its temperature. Seeing that Porter's tables are conveniently bound up for reference in the back of the book, I can only express my surprise that you did not verify the correctness of my assertion by glancing at the figures in columns two and three of these tables.

You then say, referring to another of my statements, that you see, for the first time, horse power defined as the engineering unit of virtual velocity. Very good. But is not the definition correct, all the same?

Referring to my remarks on momentum, which I can assure you were not hastily penned, you object to the clause which says "Momentum represents the stored or acquired energy of weight acting through time," on the ground that it might be construed to show that a body at rest could acquire energy by acting through time. I reply: Scarcely, for I had just defined momentum as "quantity of motion," and explained that the momentum of a body moving with a certain velocity is equal to its weight

into the time during which it would have to fall under the influence of gravity in order to acquire that velocity. The paragraph should be read in its entirety. If, in the formula which I give for momentum, velocity is made equal to zero, as occurs when a body is at rest, then the resulting momentum of that body becomes also equal to zero, as it should. To prove that I am wrong you then give the example of a 10,000-ton ship acted upon by a weight of 1 lb. for a period of 100 seconds. To which I reply that your data neither suffice for the use of the formula which I give nor conform to my definition of momentum as quantity of motion, and therefore your example proves nothing.

Your final remarks on my observations upon vis viva do not seem to call for any reply because I do not find that they seriously challenge my assertions.

I cannot agree with you that I should have done better had I used the words of Rankine and of Clark instead of my own. I grant you that their words are infinitely better than mine, but I do not think I would have been justified in rehashing them in a volume purporting to be written by myself.

I cannot but regret that you have conceived it to be your duty to search only for defects in my little volume. I think if you had read the book more dispassionately you would have detected some of the merits which other competent authorities have found it to possess.

Very faithfully yours, E. Sherman Gould.

Yonkers, N. Y., July 14, 1898.

(We give space with pleasure to Mr. Gould's defence of his book, but must reply to one or two of his statements. We find the term "sensible heat" in a column of the steam tables in the back of the book, said to be taken from Porter. We have not Porter's book at hand to refer to, but it also has made a slip if it uses the term "sensible heat" in this way, for the thing signified is not "sensible heat," but the total heat (above 0° F.), measured in B. T. U. in 1 lb. of water of the temperature given. The term "sensible heat" we take to mean heat that is perceptible by the senses, to give it any other or arbitrary significance appears to us a misuse of language, but it may be that Mr. Gould is not the one originally responsible for this.

"The engineering unit of virtual velocities is the horse-power." Is this a correct definition? We think not. As stated by Mr. Gould, the equation of virtual velocities obtains when $P\ V = P_1\ V_1$, in which P and P_1 are the weights of two bodies, and V, V_1 their respective velocities. According to Coxe's Weisbach, p. 209: "If a system of forces which act in a plane have a motion of translation, then the work done by the resultant is equal to the sum of the work done by the components," and this statement is given as the "principle of virtual velocities." Rankine's Applied Mechanics, p. 479, defined the "principle" as "the name given to the application of the principle of conservation of energy to the determination of the conditions of equilibrium amongst the forces applied to any connected system of points." We fail to find in these definitions any suggestion that there is such a thing as a "unit of virtual velocity," still less that a horse-power, which is the unit of rate of work, or the foot-pounds of work done in a minute divided by 33,000 can be such a unit.

"Momentum is weight into time." Mr. Gould satisfactorily explains what he means by this expression, and we now understand that the momentum of a ship moving at the rate of 1 mile an hour is equal to its weight multiplied by the time during which it would have to fall under the influence of gravity in order to acquire that velocity; but it would have been better, it seems to us, to give the term momentum the usual definition, the product of mass, or weight ÷ g, into velocity. His statement that, momentum represents stored energy, however, is still inaccurate, for momentum is m v and energy is $\frac{1}{2}$ m v^2.—Ed.).

Notes and Queries.

Heating Surface per Horse Power (Correction).—In the abstract of Mr. M. C. Huyette's paper on "Boiler Furnaces for Steam Power Installation," on p. 47 of our issue of July 21, 100 sq. ft. of heating surface per horse power is a misprint for 10 sq. ft.

F. M. T. asks our authority for the depths of harbors of the United States given in our editorial of July 21, p. 41.

We compiled the table from "Bulletin No. 36, U. S. Coast and Geodetic Survey. Table of Depths of Channels and Harbors, Coasts of the United States," issued in 1897.

A YEAR'S PROGRESS IN ENGINEERING.*

It was formerly the duty of the President to give a summary of the progress in engineering during the preceding year. This duty does not now exist, but, inasmuch as a number of my predecessors have selected other subjects for their annual addresses, I have thought it proper to return to the old practice, although the engineering field has now become so large that a short paper can give but a very incomplete sketch of the subject.

Railway Construction.

The mileage of railways built in the United States in 1897 (2,108 miles) is not extensive. It hardly varies from the mileage built in 1896 or 1895, is a little lower than that of 1894, and far below that of 1890 to 1892, and earlier years. Of the separate states, California leads with 221 miles. Canada returns 395 miles, and Mexico 367 miles. In Canada the Canadian Pacific Ry. has done a vast amount of work in converting temporary into permanent work, and in reducing the grades in the Rocky Mountains; and improved transportation facilities for the grain trade have been inaugurated by the construction of the Ottawa & Parry Sound Ry. extension to Parry Sound on Lake Huron.

In the last fiscal year 714 miles of Indian railroads were opened, and the total mileage now is nearly the same as that of the United Kingdom. In Japan the progress is marked. In March, 1897, the passenger traffic was reported to be 21.2%, and the freight traffic 15.1% larger than during the previous fiscal year, and further development on a larger scale is contemplated and partly begun. In China, while at present there are only 300 miles of railway, additional lines, involving a much larger development, are now projected, under the auspices of several European nations. The great Trans-Siberian Ry. is advancing steadily toward its eastern terminus. In Africa the Congo Ry., from Matadi to Stanley Falls, constructed by Belgian engineers with Belgian capital, is expected to be opened before the end of this summer, and the Bulawayo Ry., in South Africa, was opened a few months ago. Even in Abyssinia a line from the coast to the interior of the country is projected.

Improvements in Railway Operation.

In the United States, while the actual amount of construction has not been large, the general tendency has been toward an increase of speed and safety, which has been attained by the introduction or improvement of such devices as heavier rails, the air brake, the interlocking system of signals and the strengthening of cars. The block system of signals is now so common that it is difficult to realize at the time of the World's Fair, in 1893, only one line of railway in the United States was fully provided with it.

The equipment in general is being perfected, heavier locomotives are being built, and the compound locomotive is being slowly introduced with promise of success. Efforts are especially being made to secure uniformity in mechanical devices. The result of the labors of a committee of this Society has had much to do with the introduction of uniform rail sections, and you will be called upon here to decide whether a similar committee shall be appointed for the study of a uniform type for rail joints. Notable progress toward the abolition of grade crossings has been made, in and near a number of cities.

In recent years extensive and more commodious terminal and union stations have been built in large cities; a conspicuous instance is the Southern Union Station now being built for a part of the railway system which terminates in Boston.

Street Railways and Electric Locomotives.

Within a few years the development of cable and electric railways has been phenomenal in the United States and all over the world. The advent of the trolley car has revolutionized travel, and affected the movement of population in the neighborhood of large centers. In some instances, electric traction has begun to compete with local steam railways, and the cheap fares made possible by its economical installation have placed travel for business or for pleasure within the reach of the poorest. Compressed air has also come to the front; as an instance of it, compound air motors for certain lines of street cars in New York city are now contracted for.

Among the successful examples of electric propulsion may be mentioned the Baltimore Belt Line of the Baltimore & Ohio Railroad; the electric high-speed suburban service about Cleveland, including six different lines and covering long distances, and many others in various parts of the country; the Chicago elevated railways; the proposed systems of rapid transit in New York and Boston; the Boston & Nantasket branch of the New York, New Haven & Hartford R. R.; the third-rail electric system between Berlin and Hartford, Conn. We may note here that the question of rendering the third rail innocuous after the passage of each train is apparently solved.

In England the Metropolitan Ry. Co. and the Metropolitan District Ry. Co. have already acquired the necessary parliamentary rights to adopt electricity as their motive power, and are said to be waiting until the new Central London Ry., the greatest electrical enterprise in England, shall have been in operation. In France, the proposed new terminal of the Orleans Ry., consisting of 2½ miles of underground railroad in the heart of the city of Paris, is an important enterprise.

Canals.

One of the most important questions in the United States is that of the connection between the Great Lakes and the Atlantic. A United States commission is now at work on a report as to the best plan to be recommended. Opinions differ materially as to the advisability of building from the Lakes to the Atlantic a deep ship waterway or one of smaller dimensions. In the meantime the state of New York is at work increasing the depth of the Erie Canal to 8 ft.

At Sault Ste. Marie, in 1897, the traffic of the ship canal amounted to 18,954,000 tons, a tonnage much larger than that of the Suez Canal. The Montreal, Ottawa & Georgian Bay Ship Canal, by way of Georgian Bay and the Ottawa River, which, it is said, will save 1,100 miles between Chicago and Liverpool, should be mentioned.

The recent naval operations connected with the present war with Spain have revived the question of the American Isthmian canals. The feasibility and cost of the Nicaragua Canal are now being investigated by a United States Commission. The report of a previous commission concluded that the canal is feasible, but at an estimated cost higher than was reported by the original promoters of the enterprise. In the meantime, the new Panama Canal Co. is at work on the Isthmus, and is now making a further engineering study of that work, with a view of deciding whether the undertaking can be profitably pushed through. If the report is favorable, an effort is to be made to find the necessary capital for the completion of the canal. In both cases it appears that construction was begun without sufficient data, and that the most serious engineering question to be solved is the proper and safe disposition of the freshets caused by the great rainfalls of the wet season. The necessary investigations are now being made.

In France, the proposed canal from the Atlantic to the Mediterranean has been finally abandoned as too costly. It is reported that the Suez Canal is to be deepened. In Russia, a ship canal, to join the Baltic and Black Seas, is to be begun next spring. Of the 1,080 miles, the reported length of the canal, 875 miles are to be in canalized rivers, leaving only 125 miles to be excavated. In Italy, the regulation of the Tiber River is nearly completed. This is an important work, the total cost being estimated at $21,000,000.

The following statistical figures as to the cost of large canals in various parts of the world are thought to come from a reliable source:

Name.	Length, miles.	Years building.	Total rock & earth, cu. yds.	Cost.
Suez	66	9	80,000,000	$100,000,000
Corinth	3.7	12	15,220,000	15,000,000
North Sea	61.5	8	.....	37,440,000
Chicago	40.6	5	40,000,000	25,300,000
Manchester	35.5	6	53,500,000	77,000,000

Bridges.

In the construction of bridges, the last few years have seen a further development in the designs of structures for large spans. The United States government has required the building of such bridges, up to 1,000 ft. span, over the Ohio, Mississippi and other rivers. The necessities of the traffic of New York city have given renewed impetus to the designing of suspension bridges of unprecedented span, and have caused the introduction of novel details, made practicable by recent improvements in the manufacture of steel. The perfection of the methods for erecting long and high-span trusses has also rendered these operations much more satisfactory as to cost, and as to the important element of the time necessary to carry them out. The recent reconstruction of the Niagara Falls Bridge is a conspicuous instance of the best modern engineering in that field, and the new East River Bridge will probably be the prototype of others.

The various designs for a much larger suspension bridge over the Hudson River are familiar to you, and have carried the possibilities of bridge building much beyond long-accepted limits. The famous Victoria Bridge, justly considered at the time of its construction a bold and novel undertaking, has outlived its usefulness, and is being replaced by a modern steel structure of 20,000 tons (with 24 spans of 254 ft., and one of 350 ft.), which will be far lighter and cheaper, although of greater strength, than the original bridge.

There has been a tendency in recent years to return to the construction of stone arch bridges, wherever local conditions as to cost of foundation and length of span have justified the generally larger outlay necessitated by this class of more permanent structures. In this connection, the recent introduction of the three-hinged masonry arch must be noted. The Melan arch, of which many examples have been presented in recent years, has pushed to the front the principle of the mixed construction of masonry and metal. Although, owing to the changes of form produced by varying temperatures and by the internal movements due to the behavior of masonry before it is entirely set, there may remain some doubt as to the perfect homogeneity of this class of construction; success has, undoubtedly, been achieved in many cases, but time alone can give final sanction to the

*Slightly condensed from the address of President Alphonse Fteley at the Detroit meeting of the American Society of Civil Engineers.

wide adoption of structures of this class. The arch bridge at Topeka, Kan., said to be the largest of that description, costing $150,000, and containing only 140 tons of steel, is a conspicuous instance of this method of construction.

High Buildings.

When the modern high building of skeleton steel with masonry walls was first introduced for business purposes, some doubts existed as to its permanency. Many new problems as to the stability and fire-resisting properties of such buildings presented themselves, but the complicated questions of their equipment, including untried methods of carrying passengers, and of supplying water, sewerage, heating, ventilation, etc., appear to have been solved satisfactorily. High buildings have been erected on various kinds of foundations. In many cases solid rock has been reached at great depths, and compressed air has been resorted to in the building of the main supports; in others, the weight has been so distributed over uniformly yielding materials as not to tax them beyond practical limits. Frequently, where the resistance of the ground was not uniform, the adaptation of various parts of the structure to the weight to be supported at each place taxed to the utmost the ingenuity of the builders. In certain cases, mechanical devices have been introduced for the purpose of meeting possible irregular settlements. The distribution of weight on yielding foundations has often been accomplished by clusters of steel beams imbedded in concrete. At times, when the foundations of proposed structures extended below the lowest point of the foundation walls of neighboring buildings, it was necessary to support the latter, and at the same time not to interfere with the operations of construction, generally conducted on restricted areas; this result was accomplished by the introduction of novel and ingenious devices. The necessity for reducing the weight of buildings has resulted in the reduction of the masonry part to a minimum by the adoption of floors which possess lightness and strength as well as fireproof qualities. The rapidity and ease with which these extensive buildings are erected without extraordinary impediment to travel in crowded streets is remarkable.

The future of the high building, with its many parts out of reach, and without possibility of examination and maintenance, is now difficult to predict. Several modern fireproof buildings have stood well the test of fire, but no great conflagration has occurred to show what the results of such a contingency would be. In a recent earthquake on the Pacific Coast, modern high buildings are reported not to have suffered.

Outside of constructive possibilities, however, other questions which may have an important bearing on the future of high structures present themselves: Their influence on real estate values, on the growing accumulation of population in the business districts, and on the problems of water-works and sewerage. Should the erection of high buildings extend more and more, the sanitary condition of the people passing a part of their life in districts thus built up would become a serious question, and one which should be taken in hand by the proper authorities. The height of these buildings is now, in many cases, too great, and if this style of construction is to go on it is most probable that it will be limited everywhere by law, as has been done in several cities.

Harbor Improvement.

The constantly increasing size and draft of large vessels for commercial and military purposes make it necessary in many cases to deepen harbors, and also enhance the cost of docks, dry-docks, and of all structures connected with river and harbor works, the size of which depends upon the depth of adjacent waters. For the purpose of facilitating navigation in rivers and harbors, great improvements have been made in dredging apparatus, the capabilities of which have rendered possible excavations which would have otherwise required too much expenditure of time and money. In this country the dredging operations on the Mississippi River have reached an unexpected development and success.

The great docks of Duluth and Superior, recently built to accommodate the large grain crops of the two Dakotas and part of Iowa and a great amount of iron ore, coal and other products, the new Liverpool docks and the recent dock improvements of Dunkerque and Calais, are examples of modern designs in that line. In this connection may be mentioned the new breakwater, 20,000 ft. long, under construction by the Government at Buffalo, which is the largest on record.

Public Water Supplies.

The number of places in the United States now possessing a public water supply, whether under public or private ownership, is nearly 4,000; but, while systems of works increase in number and importance, it would seem that we lack in this country the faculty of properly regulating them as regards the quantities to be furnished. In large cities, with some exceptions, the per capita consumption is increasing, and in several of them the amount consumed attains absolutely inordinate proportions, although, in some of them, every gallon of it has to be pumped. The old cry that water in our communities should be as free as air is heard from people, who from their intelligence and business habits should know better, and the taxpayer does not stop to think of the result of extravagance in water consumption. More water means more and larger pipes, more capacious reservoirs, more pumping stations, and, in many cases, new sources of supply, with the attendant large outlays necessary to procure them. It also means increased risks in some cases, as in New York, it becomes a problem to locate water pipes properly in already crowded streets. That there is a large waste of water is admitted by all, but the means of checking it are not generally applied. Objections are raised as to a more extended system of making consumers pay for the amount of water actually consumed, and clumsy and inaccurate methods of estimating the amount and value of the water used are resorted to, which not only would not be tolerated for the sale of other commodities, but would be considered absolutely ridiculous.

The consequences of excessive consumption of water are ominous. Take the case of New York: In 1890 its new aqueduct was put into service, the consumption then being 110,000,000 gallons per day. After nearly eight years, the average for 1897 was 230,000,000 gallons per day, a per capita rate of about 115 gallons. At this rate the new system of water supply begun over ten years ago and constructed at a very large cost will soon be insufficient in a dry year, and new sources will have to be developed at a much greater cost.

The large cities of this country, which, located on the sea coast, have no fresh water within easy reach, have generally taken too great risks in the matter of their water supply, and it is to be wondered at that no harm has resulted from this policy; those especially where the density of the population is great should have more than one system of water supply, and it is to be hoped that this view of the subject may be adopted.

Water Purification.

With the advance of sanitary science the need of purer water has been felt, and efforts have been made in many directions to improve public water supplies. Where they are obtained by impounding river waters in storage reservoirs formed by damming the streams, great inconvenience has been felt from offensive tastes and odors, generally produced by the development of microscopic vegetation. Efforts have been made to improve the gathering grounds and the reservoirs, and in a number of cases, especially in and about Boston, the soil, down to the underlying sand and gravel, has been removed at a large expense, to the great benefit of the impounded waters. In cases where the same inconveniences have been experienced in underground waters pumped into reservoirs exposed to the light, a notable improvement has been produced by covering the reservoirs.

Much attention has been given in late years to the study of filtration processes. Thirty years ago, an eminent member of this Society and one of its late Past-Presidents, prepared, for the benefit of the St. Louis Water-Works, a report on "Water Filtration," which, for many years, was the most valued text-book on the subject. It was then thought, and it was so maintained for many years, that hardly any chemical action took place in the filtering of water, and that the main function of the filter was to retain the particles suspended in the water, very little action taking place on matters contained in solution. Little was known of the influence of filters on bacterial life. Within recent years, however, especially through the efforts of the Massachusetts State Board of Health in conducting at the experimental station at Lawrence its well-known series of experiments, results have been obtained which have revolutionized the theory of water filtering. Radical chemical and biological changes have been found to take place in the operation of filtering, and bacterial life has been recognized as the most potent instrument for the conversion of organic matters into mineral compounds, while it operates at the same time as an agent of almost complete self-destruction, provided, of course, that the construction of the filters, the selection of the filtering materials used and the subsequent care of the apparatus are such as to properly carry out the results indicated by the laboratory experiments.

A number of different materials have been recommended and used as filtering media with varying success; the most extensively used have been sand and gravel. Sand filters have been in use in Europe for many years, long before the full measure of their usefulness was known, and the modern applications of the system have been highly instructive. We all recollect the striking results of the differences in mortality in Altona and Hamburg during the recent epidemic of cholera, when the first-named city, with a water supply polluted by sewage, but filtered, showed only sporadic cases, while in Hamburg the water supply, less polluted, but not filtered, was recognized as the cause of the heavy mortality recorded. No large systems of what may be called gravity sand filters exist in America, but important communities have been recently and are now making extensive experiments with a view to building some, and in one instance at least, in Albany, a system of filters on a large scale is now under construction.

In mechanical filters, in which various filtering substances, mainly sand, are used, coagulants are generally used to eliminate a large portion of the organic and other matters contained in the water, and sufficient pressure is applied to force the water through the filtering medium so as to cause a flow of water larger than through gravity filters, per unit of area. They have been used for years and have recently been so perfected as to be reported by their inventors as capable of successfully competing with gravity filters in cost and in efficiency. Two very important series of experiments have been made by large cities to investigate the merits of the mechanical filter. Further developments and added experience will evidently be needed to decide the question. From reports made by capable experts in behalf of communities in search of advice for the purpose of constructing filtering apparatus, it appears that the choice between the two systems, in many cases, must be determined by local circumstances, depending mainly on the cost of the filtering materials and on the quality of the water.

The public appears to realize now, more than ever, the desirability, if not the absolute necessity, of procuring purer water, and the close connection between pure water and improved public health is better understood by public bodies. From an economical standpoint alone, when considering the commercial value of each human life, the saving effected by diminishing the mortality would represent a large capital.

Water Pipes.

Construction has been favored by the decreasing price of iron and steel. The price of cast-iron pipes, especially, has never been so low as it is at present. Steel riveted pipes, for the conveyance of water from the source of supply to the point of consumption, in recent years have been introduced more liberally in the East. For long distances, with large diameters, under heavy water pressure, especially when few connections have to be used on the way, these pipes are as much superior to cast-iron pipes as the steel substitute is to the old cast-iron tension member of a bridge, and it is not doubted that they will be ultimately used to the exclusion of others, but, unfortunately, although similar pipes made of wrought iron have been successfully used for years on the Pacific coast, and elsewhere, it cannot be said that the coatings used to preserve the metal from oxidation are entirely satisfactory. The rivets used for fastening the pipes and the lapping joints impede the flow to a certain extent, and a pipe has been devised, the fastenings of which are entirely outside and provide the pipe with a smooth bore. The great improvement in steel-welded pipes of large diameter will also remedy that defect to a large extent. An order is reported of several thousand tons of welded pipes to be made of Siemens-Martin mild steel, 24 ft. long and 42 ins. in diameter, for the Birmingham Water-Works. The possibilities of steel pipes are well illustrated by the proposition to convey a much-needed supply of water, of 5,000,000 gallons per day, to a mining district of Western Australia, by means of a pipe 30 ins. in diameter and 328 miles long.

Dams and Reservoirs.

The construction of water-works and of irrigation works has rendered necessary, in recent years, the erection of many dams for the impounding of water, a number of them being of great height. Few new principles of construction have been introduced, but improved methods for the building operations have been resorted to, thereby reducing the ultimate cost and the time necessary for the completion of the structures.

The solid stone masonry section on the general plan originally introduced by the French engineers, has been accepted in many places; the general practice now being to use large stones with the necessary filling of spawls instead of the uniform small-stone masonry, formerly adopted and even recently recommended by eminent engineers. Elsewhere, concrete masonry has been adopted, this course being generally indicated by local circumstances, such as the high cost of, or even the lack of, stone in the vicinity. In recent instances of concrete dams slight vertical cracks have developed which have been less frequently found, if at all, in well-built stone masonry, owing probably to the more thorough bonding of the mass by means of the interlocking of heavy stones. In the western part of the United States rock-filled dams have been built, the imperviousness of the structure being procured by the construction of core-walls, by the building of a timber lining on the up-stream side or by other devices. The earth dam continues to be universally used; parts of India and of the United States showing recent instances of this mode of construction for high dams, mostly with the aid of puddle, or masonry and concrete core-walls. A peculiar core, formed of thin sheet iron, used in connection with a recent rock-filled dam in California is worthy of notice, if not of imitation.

It is to be regretted that theoretical calculations cannot be accurately applied to the computations of the stability of dams. The distribution of strains through such masses is not well known; moreover, the diversity of the materials used; the unavoidable lack of uniformity in the labor employed, the different times of the year in which the work is performed under varying temperatures, are all elements which cannot be accurately analyzed, although they can be provided for by the introduction of the too often necessary margin of safety. Experience must here come to the rescue of the designers, and dictate the necessary precautions to be used in accordance with known precedents. Especially is this true of the designing of earth dams, for which, in almost every instance, a careful study must be made of the particular materials at hand for construction.

The uncertainties just alluded to have been eliminated in the design of a dam of moderate size, the building of

which has been recently reported. It is formed of steel columns and struts reposing directly on the bottom of the valley, the up-stream side being formed of steel plates rendered water tight by the application of a bituminous coating. It is possible that in many instances the cost of such a design would be too high for practical purposes, and some of its features may not be unobjectionable, but it is noteworthy.

Many dams of importance have been recently constructed or are in process of construction or of preparation. The Periar dam, in the Province of Madras, 173 ft. high, was completed in 1893, under exceptional difficulties, for irrigation purposes. The dam built for the water-works of the City of Remscheid, Germany, was also recently erected. In the masonry dam of La Tache, in France, the old French practice of using such small stones only as two men could carry has been continued, although convenient quarries were at hand. The new Croton Dam for the water-works of New York, to be of masonry and earth work, a structure of great height and involving the laying of over 600,000 cu. yds. of masonry, is well advanced.

In the states of California and Arizona especially a large number of dams, mostly for irrigation purposes, have been recently completed or are being erected. The Upper and Lower Otay dams, one of them provided with a thin steel core, are important in size. Several masonry dams in Arizona, of great height, may be mentioned; one of them to be 250 ft. high above foundation, and to form a reservoir of the enormous capacity of 1,020,000 acre-feet. La Mesa dam, in California, was built with materials transported and deposited in place by flowing water, by the process known to miners as "ground sluicing." Another, to be 130 ft. high, is expected to be built by the same method. The Louisa Needle Dam, built for the regulation of the Big Sandy River, Ky., recently completed, is remarkable from the fact that it sustains a head of water which considerably exceeds that supported by any other dam of the trestle or wicket type yet constructed.

As the needs of water supply and irrigation call for higher dams, the reservoirs formed thereby are obviously increasing in size, and figures are now being reached as to reservoir capacities, which recall the size of the great ancient reservoirs, the knowledge of whose existence has been transmitted to us by tradition, if not by history. The idea of the restoration of the great compensating reservoirs of the Nile, spoken of some time ago, does not appear to be any longer entertained, but the erection of two dams across the river, with a proposed storage of 266,000 million gallons, for the purpose of regulating its flow, is now being seriously contemplated, if not already started. The system of compensating reservoirs for the Mississippi Basin is well under way.

Sanitary Engineering.

The construction of sewers keeps pace with the general development of municipal engineering; the second part of the metropolitan system of sewers for Boston and the neighboring cities and towns has been practically completed; the great Drainage Canal of Chicago is approaching completion, and, in connection with it, intercepting sewers of large diameter are being built under peculiar difficulties; many other systems of sewers are in process of construction or in preparation.

The question of the disposal of the sewage from cities and towns, in view of preventing the pollution of streams, is especially occupying the attention of municipal engineers. Many reports recently made on the subject have attracted the attention of the profession, and in several states commissions have been appointed for the purpose of studying this problem in reference to the welfare of adjacent and neighboring communities. Those who are studying these questions, however, are much hampered by the lack of proper laws, and, in many cases, special legislation must be procured. A commission has been recently appointed in the state of Connecticut for the abovementioned purpose, and the state of New Jersey is now attempting to procure the necessary legislation in order to properly define the rights and duties of the various communities interested in the purification of the Passaic River, now much polluted by sewage.

The practical applications of the various systems of disposal of sewage are comparatively few in this country, although new works of that description, on the principle of irrigation, filtration and chemical precipitation, have been inaugurated within the last few years. The chemical precipitation system of London, with its production and disposal of 2,000,000 tons of sludge in 1897, remains the largest exponent of that class of work.

Paris completed in 1895, by means of the Acheres Aqueduct and Park, a large addition to its irrigation system which disposes to-day of one-half of the total flow of the sewers of the city, and Berlin has so added to its irrigation fields that their total area is 20% larger than that of the city.

Much attention is being given in many directions to the disposal or utilization of the waste of large cities. Cremation processes appear to be looked upon with increased favor as being the more economical; great advance has been made in that direction in Hamburg and Berlin. It would seem that the greater amount of coal wasted in this country should make this process more successful. Reduction processes of various kinds have met abroad with a moderate degree of success. Several important plants have been and are being built in the United States; they have not been an entire success so far, and may be said to have hardly passed the experimental period.

Tunnel Construction.

The construction of recent tunnels for railroads, waterworks, sewers and other purposes shows marked progress. Tunnels are driven at a more moderate cost, in less time, and difficulties are surmounted with greater ease. In crowded streets, underground building operations, at times very near the street surface, have taken place with least injury to buildings and without interruption to traffic or danger and inconvenience to citizens. Parts of the London Metropolitan Railroad, the underground railroad under the Boulevard St. Michel in Paris, and the partly completed subway of Boston, are conspicuous instances of tunnel operations conducted in accordance with the most recent methods. By similar means, one of the main French railroad lines is to transfer its terminus from the outskirts of Paris to its most central part. The proposed underground Rapid Transit system of New York city may soon give another illustration of the possibility of building conveniently and rapidly through crowded streets. With the perfected driving shield, the use of compressed air, and the methods of excavation recently used, few difficulties would appear to be insurmountable.

The project of the Simplon tunnel through the Alps is coming to the front again, and although not yet fully financed, construction is soon expected to start. It is 15 miles long, and, notwithstanding its great length, is expected to require one-fourth the time devoted to the construction of the Mont Cenis Tunnel, and to cost one-half as much.

With the advent of electric propulsion, the necessity for thorough ventilation in tunnels used for urban transportation does not appear to be considered so important as formerly. It is to be hoped that efforts are to be made to so renew the air in tunnels as to reduce to a minimum, when required, the atmospheric differences between the inside and the outside; the changes experienced in some of the existing structures being sufficient to materially affect public health.

Application of Electricity.

The science of electricity has advanced by such strides that its evolution, it may be said, brings every day new surprises, and that its application to engineering purposes requires the attention of specially trained men. A few words have already been said of the adaptation of electricity to traction. There is, indeed, hardly a branch of engineering in which it cannot be introduced with success.

Its extensive application to the treatment of metals forms the subject of the recent annual address of the President of the Institution of Electrical Engineers of England, and its use in mining operations is being gradually extended. Its universal introduction for the production of power covers a field the limits of which it would be difficult to define. The substitution of individual electric motors in the place of shafting and pulleys is gaining ground, and the improvement thus accomplished has been so important as to already cause a marked movement toward a radical modification in the construction of mills, which can in this way be built more economically and with better conditions as to light and ventilation. On the other hand, flexible transmission by cable (except for traction purposes) is steadily losing ground.

A new impetus has been given to the development of water power plants, which, prior to the introduction of electricity on so large a scale, had lost much of their importance. England, France, Germany and Italy present interesting instances of these modern establishments, and you have heard of some of the largest enterprises in this country and Canada where immense power is now, or is to be, transmitted to great distances.

Engineering Researches.

It is gratifying to state that in many a branch of engineering, experimental researches have been recently made, and are being conducted, and that data of great value are being accumulated. The Massachusetts State Board of Health is continuing its remarkable series of experiments, which have already contributed so much to the development of sanitary science; tests of materials of all kinds have been extended and systematized, and much is expected from the experiments conducted by the American Section of the International Association for testing materials. Mechanical tests of American timber have been made, and are being continued by the Forestry Division of the United States Department of Agriculture, which have already contributed to the subject of timber physics many new facts and experimental knowledge of great value.

Tests have also been recently conducted which throw much additional light on the composition and resistance of fireproof floors and of the bearing power of those in which concrete and steel are united.

In hydraulic engineering we may mention the extensive gaging of streams conducted under the direction of the United States Geological Survey; the continued painstaking experiments of M. Bazin on the flow of water in open channels; experiments made to ascertain the loss of water from reservoirs by seepage and evaporation; extensive tests on the percolating capacity of certain sands and gravels, made by the Engineering Department of the Metropolitan Water Board of Massachusetts; and a number of interesting gagings to determine the flowing capacity of long pipes for the conveyance of water, one important instance of which is to be presented to you at this meeting.

When summing up the conclusions of such experiments the results obtained are frequently represented by algebraic formulae, which are apt to be interpreted as being of a general character, while they give the facts between certain limits which are not always sufficiently defined in the accounts given of the experimental work. Formulæ, correct between certain limits, may be grossly erroneous when applied outside of them. To avoid this objection, sometimes a serious one, the custom should be encouraged of publishing, at the same time as the deduced formulæ, diagrams of the results obtained, and at the same time the limits beyond which the given experiments do not apply.

The Professional Standing of the Engineer.

We may well ask ourselves whether our profession is recognized by the general public as it should be. The mission we have to fulfil is in no way inferior to that of the other professions. On the engineer depends often the integrity of the capital invested by those who repose their confidence in him, and on the soundness of his designs frequently depends human life, and yet, when the learned professions are enumerated, the engineer is often passed by. This is probably due to the comparative youth of our profession in this country. A generation ago the scope of its usefulness was very much more limited, but the field is being extended at such an increasing rate, and the money invested in engineering enterprises of all kinds is correspondingly so much greater, that our profession is steadily gaining in importance and standing. It is obvious that we can all contribute to that result by our individual professional efforts in our respective fields.

As our work extends, we cannot but feel the need of increased knowledge. In that respect we have much better facilities than our predecessors, as, through professional papers published by engineering societies, and through the engineering press, we can keep abreast of the times, and the educational facilities are much greater. The yearly addition, to the profession, of students who are graduated from engineering schools, favors the dissemination of technical knowledge in many directions, as, owing to their large number they may not all be able to procure purely engineering positions, but must find new openings in the industrial world and in other channels, thereby carrying professional knowledge where it will be found of great value.

While we review the field covered by our profession, it is gratifying to notice that the names of members of this Society constantly occur to us as having had an important part in the advancement of all branches of engineering and in the erection of the most important works executed in America. Moreover, through our foreign members and a few of our American brethren, our Society is by no means a stranger to the engineering practice of the rest of the world. This is as it should be, and as it was foreseen by the founders of the American Society of Civil Engineers; and, owing to its increasing importance, membership in its body will logically become more desirable.

The number of members of all classes is now 2,119, not including over forty applicants now before the Board of Direction. This is a large gain since the beginning of the present year.

When following in the steps of our predecessors in the field, the Institution of Civil Engineers and the Society of Civil Engineers of France, we decided to provide new headquarters for ourselves, the time was very opportune. Convenient as our former building had been, it had become insufficient for our requirements, and greater delay would have caused great inconvenience and detriment. The experience of nearly one year fully justifies the action taken. Our new house has added not a little to the standing and dignity of our body, and the advantage gained amply compensates the increased outlay necessary for its maintenance, a burden that our Society, in its sound financial condition, can well sustain. We have entered a new era of successful life, and, in conclusion, allow me to express the wish that the increasing importance of our profession be the sure omen of the continued prosperity of the American Society of Civil Engineers.

COMPARISON OF RECENT SPECIFICATIONS FOR FINENESS AND TENSILE STRENGTH OF CEMENTS.

In our issue of April 28 we published in tabular form the principal requirements in the specifications for cement formulated by the officers of the Corps of Engineers, U. S. A., for the works in their charge. A similar comparison of the principal requirements for fineness of grinding and tensile strength, embracing both Portland and natural cements and both European and American practice in railway, municipal, bridge and other private work as well as government work, has been brought to our attention by Mr. R. W. Lesley, Vice-President of the American Cement Co., of Philadelphia, Pa., and is abstracted here to supplement the information already given in

TABLE I.—Showing Requirements for Fineness of Grinding and Tensile Strength of Portland Cement in Specifications for Various Classes of Work in the United States.

Specification.	Per cent. passing 2,500 sieve.	Per cent. passing 10,000 sieve.	Lbs. per sq. in. Neat cement 24 hrs.	Neat cement 7 days.	Neat cement 28 days.	Mortar, 2 to 1, 7 days.	Mortar, 2 to 1, 28 days.	Mortar, 3 to 1, 7 days.	Mortar, 3 to 1, 28 days.
U. S. government engineers	95½	84	131	402	547	150	200	119	189
U. S. lighthouse engineers	95	..	..	383	600	175	250	85	..
U. S. engineers, Navy Department	90*	97†	..	462	..	..	..	..	..
District of Columbia	95	85	..	387	500	125	200	116	166
Average of nine cities.	97	89	161	388	538	158	200	134	201
" six railways	95½	80	115	319	483	123	175	108	150
" six bridges	97	88	119	347	487	142	250	132	200
" three aqueducts	..	80	110	333	400	125	200	132	225§

*6,400 mesh sieve. †3,600 mesh sieve. §One only.

the previous article. This information was collected and compiled by Mr. Lesley himself from authentic sources, and has been published in a pamphlet entitled, "A Summary of Recent Cement Specifications."

The first thing of interest which may be noted in this summary is the close agreement for Portland cement between the averages of the government specifications published in our issue of April 28 and the averages of the government specifications of the leading European countries, including Russia, Belgium, Germany, Switzerland, France, England and Norway, and also 91 miscellaneous specifications for Portland cement taken from a variety of American sources outside of government work. This fact is shown by the accompanying table, compiled from the more detailed figures:

Specification	P. c. passing sieve of 2,500 mesh.	P. c. passing sieve of 10,000 mesh.	Tensile strength, lbs. per sq. in. Neat cement 1 day.	Neat cement 7 days.	Neat cement 28 days.	3 sand, 1 cem't 7 days.	3 sand, 1 cem't 28 days.
European govmt .	92	(a)	None.	347	528	119	204
U. S. government.	..	..	144	394	536	129	199
91 miscellaneous..	96	85	134	384	528	118	189

(a) 88% required to pass a 5,800 mesh sieve.

A somewhat more detailed summary of the same figures, except that European specifications are excluded, is made in Table I. This table shows quite clearly the variety of sources from which the detailed figures come and also enables a comparison of the practice of American engineers for different kinds of work. Another fact to be particularly noted is the generally moderate requirements for tensile strength, in the 1 and 7 day tests especially.

Turning now to the detailed figures for natural cements we find the following to be the average requirements for fineness of grinding:

Specification.	Per cent. passing 2,500 sieve.	Per cent. passing 6,400 sieve.	Per cent. passing 10,000 sieve.
U.S.Engrs. in 24 works	91	85	72.5
District of Columbia...	92.5	..	80
Average of 8 cities*...	93	..	81
" 2 railways.	95	..	..
" 2 bridges..	95	..	..
" total 38 spec.	92	85	79

*62½% is required to pass a 40,000 sieve.

The requirements for tensile strength of natural cements average as follows:

Specification	Lbs. per sq. in. Neat cement. 1 day.	7 days.	28 days.	2 to 1 mortar. 7 days.	28 days.
29 government w'ks	38	102	164	*34.5	77
Dist. of Columbia..	75	100	150	50	75
Ten cities	70	134	237	†68	200
Four railways.....	64	105	163	§47	80
3 aqueducts, etc....	60	117	200	‡65	..
Two bridges	55	87.5	185	‡35	70
Average of 51 spec.	63	109	178	‖44	86

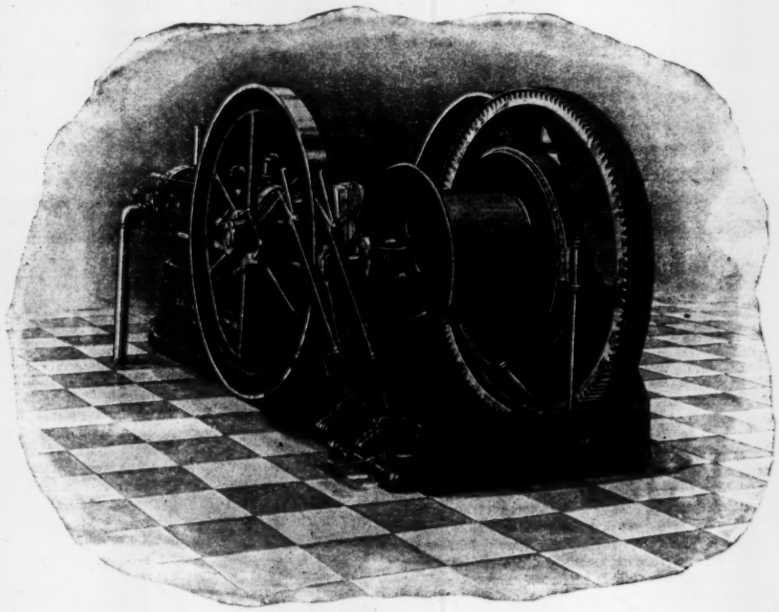
*Average of 10 works. †Average of 3 cities. §Average of 3 railways. ‡One structure only. ‖Average of 19 specifications.

There seems to be a wider margin of difference in practice in the use of natural cements, than in the case of Portland cement; but as the cases noted are practically all modern works, we must charge the wide differences of requirement to controlling local conditions.

A GASOLINE HOISTING ENGINE.

The accompanying illustration represents a simple and compact gasoline geared hoisting engine, which has recently been placed on the market, in which the entire plant is mounted on one bed-plate. The horizontal cylinder of the gas engine is at the end, the crank shaft and flywheel are at the middle, and the hoisting drum is at the other end.

The drum is loose on the shaft, to which a large gear wheel is keyed, and is gripped to or released from this gear by means of a friction clutch of special form, having a conical surface of wood, which fits a corresponding metal surface in the center of the drum. The clutch is moved along the shaft by means of a vertical hand lever at the side of the engine frame. The foot of the lever, just above the quadrant, is connected to the foot of a rocker arm or lever, to whose upper end is attached the rod of the clutch. This arrangement is shown in the cut, the clutch lever being the one nearest to the flywheel. A special advantage claimed for this clutch is that its action gives no end thrust on the drum shaft bearings. For lowering a load the clutch is released, and the drum is controlled by a hand brake on the end of the drum, this brake being operated by the other vertical hand lever shown in the cut. Both levers have latches engaging with notch quadrants, and are thus locked in whatever position they are set. If desired, the levers can be placed near the head of the mine shaft or level, and connected to the engine by rods or other suitable connections, so that the attendant can see to the dumping of the bucket.



COMBINED GASOLINE ENGINE AND HOISTING PLANT.
Fairbanks, Morse & Co., Manufacturers, Chicago, Ill.

The gearing is well supported, the spur wheel having an outside bearing, while the pinion has an extra bearing between it and the flywheel. Cut gears are used, and the engine and drum shafts have bearings of phosphor-bronze and anti-friction metal respectively. The engine is kept turning over all the time during working hours at its lowest practicable speed, and to hoist, the attendant depresses the pedal near the hand levers, and thus operates a speed changing device by which the speed is at once increased. Gas, gasoline or distillate may be used as fuel, and the cylinder charge is exploded by an electric igniter. A hand starting device is used, which has a small vertical air pump, much like a bicycle tire pump. This sprays a charge into the cylinder, and the charge is then exploded by a hand igniter. With this device one man can start the largest engine.

These hoisting plants are made in six sizes, ranging from 6 HP. to 44 HP., capable of hoisting loads of 1,150 to 6,000 lbs. respectively. They are among the gas engine specialties of Fairbanks, Morse & Co., of Chicago, to whom we are indebted for information respecting them.

ROCK-FILL DAMS IN CALIFORNIA.

A valuable contribution to the 18th Annual Report of the U. S. Geological Survey is a comprehensive paper upon "Reservoirs for Irrigation," written by Mr. James D. Schuyler, M. Am. Soc. C. E. The paper has also been published in a much more convenient form as a separate report. Several of the dams described by Mr. Schuyler have already been illustrated in this journal; but there is an especial interest in the type of rock-fill dams successfully constructed in various parts of the Pacific coast territory to meet existing conditions.

One of the largest of these rock-fill dams, and the first built in California for irrigation purposes, is in the Escondido irrigation district, San Diego Co., and has been in service since 1895, in the irrigation of about 2,000 acres of land. This district is in a valley surrounded by mountains, and the dam is located on the Von Segern branch of San Elijo Creek, at an elevation of 1,300 ft. above sea level and 650 ft. above the town of Escondido. The immediate tributary water-shed covers only about eight square miles; and as this is not sufficient to fill the reservoir with its run-off, the main supply is brought by a conduit from the San Luis Rey River. The conduit taps this river at an altitude of 1,600 ft., and it has a capacity of 28 second-feet and is 15.6 miles long. Of this distance, 67,287 ft. are in ditch, 14,142 ft. in flume and 806 ft. in tunnel. The intake tunnel, 356 ft. long through solid granite, heads in the river 3 ft. below low water level, and its lower end is excavated below grade so as to form a settling basin, in which sand accumulates at the rate of 1,000 cu. ft. daily and is sluiced back into the river. The upper 8,000 ft. of conduit is a wooden flume, supported on the slopes of a rugged canyon, with a general width of 4 ft. and depth of 3 ft. The ditch is 5 ft. wide on the bottom, with side slopes of 1 on 1, and the minimum depth is 3 ft. The total cost of this conduit was $116,328, or $1.20 per foot for construction and engineering, besides 12 cts. per foot for right of way, commissions, etc. This conduit, when running to its full capacity, can fill the reservoir in 60 days, while the drainage area immediately at the dam sometimes yields enough to fill it without this auxiliary.

The general formation is granitic, and at the site of the dam bed-rock was found about 4 ft. below the bed of the creek and nearly level across the canyon. The top soil was carefully removed over

the entire base of the dam and construction was commenced immediately upon the bed-rock, which was of the character of disintegrated granite, having harder bowlders scattered through it.

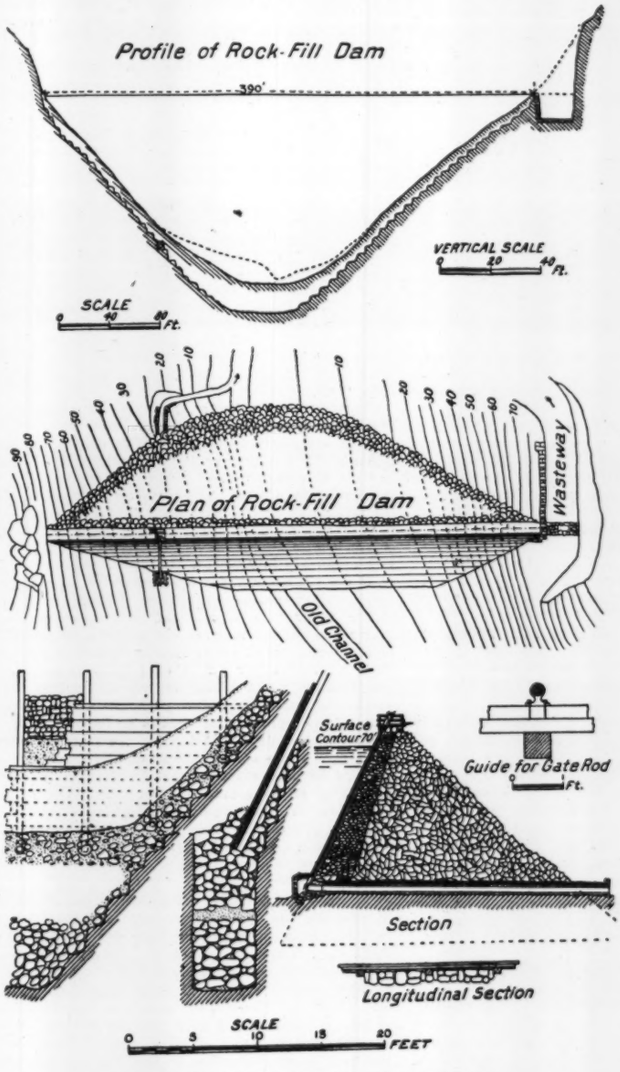
The dam was of the ordinary type of loose rock-fill dam, with plank facing; a type which has given good service in northern California for many years, but is usually regarded as being a somewhat temporary device owing to the perishable nature of the wooden skin depended upon for tightness. The Escondido dam is 76 ft. high, 380 ft. long on top, 100 ft. long on the bottom, and it has a base width of 140 ft. and a top width of 10 ft. A spillway was excavated in the solid rock at the north end, with a width of 25 ft. and its bottom on the 70 ft. contour, or 6 ft. below the top of the dam. This is left open and unobstructed. The slopes of the dam are 1 on ½ on the water face, and on the back 1 on 1 for half the height, with the lower half flattened to 1 on 1¼. After the foundations were stripped a trench was excavated at the upper toe of the dam, from 3 to 12 ft. deep, and this was filled with rubble masonry, 5 ft. thick, laid in Portland cement, to connect the plank facing with the canyon walls.

This dam contained 37,159 cu. yds. of rock, of which 6,000 cu. yds. were hand-laid in courses of dry rubble on the face, in a wall 15 ft. thick at the bottom and 5 ft. at the top. The remainder of the dam was in the form of loose, angular granite blocks, up to 4 tons in weight, dumped from cars and handled to some extent with derricks. No small quarry spalls or earth were used, and the result was a clean rock-fill which has only settled 3 ins. since final completion. A trestle was carried across the canyon, and the posts of this trestle were left buried in the embankment; a modern system of cable-way transport would have been cheaper, more rapid and better. As the hand-laid face wall was carried up, redwood timbers, 6 × 6 ins. and spaced 5 ft. 4 ins. apart on centers, were embedded to a depth of 4 ins. vertically in the masonry. To these timbers the planks were spiked, and as each row was put in place concrete was rammed into the 2-in. space between the plank and the wall, so as to give a full bearing to the plank. On the lower third of the dam the planks were 3 ins. thick; on the middle third, 2 ins., and on the upper third they were 1½ ins. thick and double throughout. Joints were broken, horizontally and vertically, as much as possible, and the joints were calked and smeared with hot asphaltum.

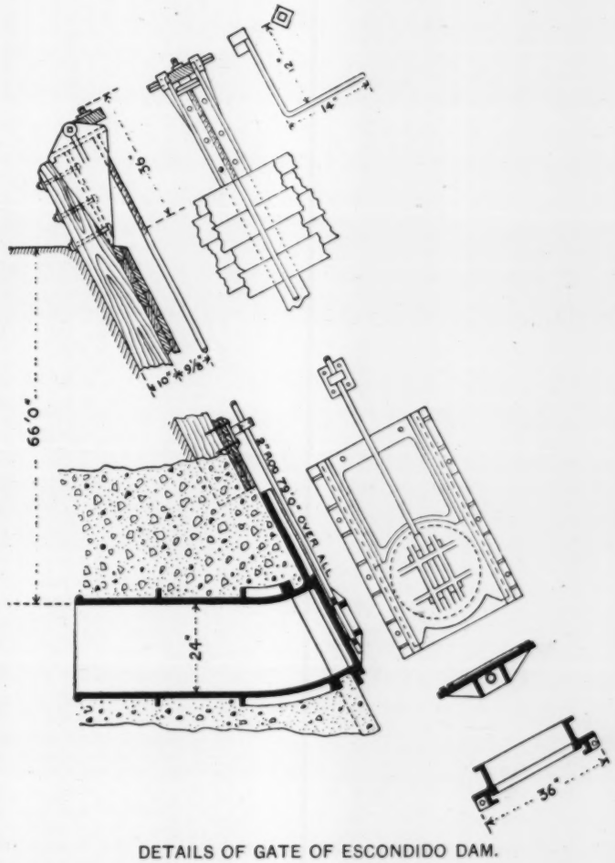
Springs were developed in the foundation excavation to the extent of 3 to 4 miner's inches constant flow. These were led by pipes to the outer toe; but when filled to the 57 ft. level, the maximum leakage was found to be 8 miner's inches, exclusive of the springs. This leakage remained quite constant, and it is doubtful whether it is due to percolation under the dam, through the disintegrated granite or to leakage through the joints in the plank facing. In any event, it is entirely harmless, though the loss of 100,000 gallons of water per day is an annoying one when it is needed for storage. The facing plank has been carried 3 ft. above the stone fill, as a wave protection, so that the ultimate crest is 9 ft. above the floor of the spillway. The outlet was originally designed to be controlled by a tower, and the foundation was laid at the upper toe of the dam on the south side; but the plan was changed; a grating was placed over the base of the tower a few feet above the gate covering the outlet; and the gate was set on an incline and controlled by a 2-in. rod leading up the incline to a worm-gear located above the crest of the dam. The outlet pipe is 24 ins. diameter, and is made of ordinary vitrified sewer pipe, laid in a trench and imbedded in concrete to a depth of 12 ins.

The total cost of this dam, under the contract, was $86,946.21, or $27.82 per acre-foot of reservoir capacity up to the floor of the spillway. The land for the reservoir site cost in addition $23,112, including clearing, and the total cost was $110,059, or $38.41 per acre-foot. The contract prices were unusually high for such work, and were as follows: Per cubic yard, earth excavation, 30 cts.; rock excavation, $1.10; rock-fill, $1.50; dry-stone masonry, $3.75; rubble masonry in cement, $8.00; concrete, $14.00; and lumber, $50 per M feet. It is the first rock-fill dam built in California for irrigation purposes; the older dams of this type having been used exclusively in mining operations.

Other dams of this general type, under construction or built, are the Lower Otay rock-fill-steel-core dam, described in our issue of March 10, 1898; the Morena dam on Cottonwood Creek, about 50 miles from San Diego; Upper Otay reservoir; Chatsworth Park, in San Fernando Valley, Cal.; and the Pecos Valley dam. The Morena dam is to be 160 ft. high and is expected to carry 150 ft. of water. It will contain 256,000 cu. yds. of stone. The outlet will be at the 30-ft. contour and consists of a tunnel, 6 × 6 ft. and 600 ft. long, cut in the solid rock, and in this tunnel will be two 24-in. and one 12-in. steel pipes, imbedded in concrete. These will connect inside with a steel intake inclined well or pipe, 36 ins. diameter, running up the side of the canyon at the toe of the slope of the dam, and fitted with 36-in. stops at every 30 ft. in height. These stops will be controlled by rods passing up the slope to the top. The dam is being built by a company under contract to deliver to the city of San Diego 12,960,000 gallons of water daily at a point four miles from the city. Mr. Schuyler says that the constructors seem to consider the services of an engineer superfluous, and there is practically no engineering



PLANS AND PROFILES OF ESCONDIDO DAM.



DETAILS OF GATE OF ESCONDIDO DAM.

supervision. The City Engineer of San Diego alleges that extraordinary negligence has been shown in laying the toe wall, which is said to have been built up 112.5 ft. high in 18 days!

At the Upper Otay reservoir the foundations were laid at the time of Mr. Schuyler's report, and while the canyon at the bottom is only 20 ft. wide, in porphyry rock, the dam may be built to a height of 100 or 120 ft. The Chatsworth Park dam succeeds two earthen dams previously carried away, and the new dam is quoted by Mr. Schuyler as an example of "how not to do it." This rock-fill dam is 41.3 ft. high above the creek bed, 100 ft. long on the bottom, and 159 ft. on top. It is 10 ft. wide on top, and slopes at an angle of 60°, or 1 on .057, on each side, giving a base of 60 ft. The water face is covered with Portland cement concrete, 8 to 16 ins. thick. The rock used for the fill is a soft sandstone, dumped in place without selection; and as everything loosened in the quarry was put into the fill, the proportion of earth and sand is very large. The angle of repose of the mass is thus flatter than that of rock alone, and flatter than the slopes proposed by the plans. The specifications were carelessly carried out, and the dam leaked considerably with 10 ft. of water behind it, and three-fourths of the lower face wall slid off two weeks after the contractor had "finished" his work. The work was done by contract for $9,000, partly payable in land. The company failed, and the dam is being reconstructed by building a dry hand-laid slope wall on the lower face, 4 ft. thick, and covering this with a masonry wall 6 ft. thick. The mortar used is half lime and half cement to three parts sand, and it will have an outer coat of 6 ins. of concrete. But all this is on the lower face of the dam.

The Pecos Valley rock-fill dams, near the town of Eddy, New Mexico, were built for storage reservoirs in 1889-90 and 1893. They differ from the others in using earth alone as a facing to stop leakage. The lower dam, built first, was 48 ft. high and 1,380 ft. long; the water slope of the rock-fill was 1 on 1½; width of rock base, 106 ft.; crown, 10 ft. wide. The earthen facing also had a crown width of 10 ft. and a slope of 1 on 3, covered with a pitching of loose stone for wave protection. This dam was ruptured in 1893 by a flood-wave in excess of the spillway capacity; a breach being made 300 ft. wide. It was immediately repaired and built 3 ft. higher, at a cost of $86,000, and the spillway capacity was increased to 33,000 second-feet, with the water 7 ft. below the top of the dam. The upper dam, built in 1893, was built in a similar manner, except that the rock-fill was made 14 ft. wide at top, and the earth fill only 6 ft. wide; the slopes remaining the same. The face of the rock-fill, against which the earth rests, was a hand-laid wall, 2 ft. thick, on a slope of 1 on ½. It required 102,400 cu. yds. of rock, 103,600 cu. yds. of earth, 3,800 cu. yds. dry retaining wall and 6,200 cu. yds. of rip-rap. It is said to have cost $170,000 complete. This dam is 52 ft. high, 1,686 ft. long, 20 ft. wide on top, and 280 ft. wide on the base. In 1895, when visited by Mr. Schuyler, it showed no signs of leakage or settlement, though the reservoir was more than half full.

BOOK REVIEWS.

UNSERE HOCHSCHULEN UND DIE AUFORDERUNGEN DES ZWANZCGSTEN JAHRHUNDERTS.—Von A. Riedler, Konigl. Geheimen Regierungerath und Professor. Berlin, 1898. A. Seydel. Paper; 10¼ × 7½ ins.; pp. 120.

In this work on "German Universities and the Demands of the 20th Century," Prof. Riedler discusses the present state of German universities and technical colleges, and raises the question whether these institutions for highest education will be able to fulfill the national tasks of the future. He claims that engineering work is the pioneer of natural science and one of the principal features of modern culture. The author develops a scheme of reform of the German universities, recommending the uniting of the existing kinds of universities and completing the old universities by technical departments, embracing the whole of technical science. He hopes that this reform will result in a much more effective scientific and technical instruction, and besides will lead to a higher social appreciation of engineers and architects than now is the rule in Germany. In case the union proposed by him cannot be brought about, the author advocates a reform of the German technical colleges, aiming at thorough economical and general scientific education, but fights energetically against the attempt to join some one or other single branch of technical science to the old universities, because it would undoubtedly perish in such isolation.

FRANCHISES AND TAXATION IN CHICAGO.—Ninth Biennial Report of the Bureau of Labor Statistics of Illinois. Secretary, Geo. A. Schilling, Springfield, Ill. Chief Special Agent, Prof. E. W. Bemis (now of) Manhattan, Kan. Paper; 5½ × 8½ ins.; pp. 320; many tables. Address the Secretary.

This volume contains some very interesting studies of the street railway, gas and telephone companies of Chicago. By showing in detail the over-capitalization of the various companies, the prices charged by them for their services and the compensation, when any is rendered, paid the city for their franchises, the report paints a dark picture. If the figures presented are reliable, and they give evidence of having been prepared with care, although many of them are of necessity only estimates, then the people of Chicago are paying enormous tribute to the companies named.

The accounts of some of the financial transactions of these companies read like fairy tales, especially those relating to Mr. Chas. T. Yerkes, who is here shown as a modern rival of Midas.

The section on taxation shows the ridiculously low assessed valuation of Chicago property, a fact also brought out in the discussion of franchises. The chapters on gas and street railways were prepared by Prof. Bemis, whose monograph entitled "Municipal Ownership of Gas in the United States" is recognized as a creditable work. The report is to be welcomed as another addition to the scanty information available regarding the operations of street railway and other natural monopolies in our great cities.

ELASTICITAET U FESTIGKEIT.—By Prof. C. Bach, K. Wurtt. Baudirector; Professor of Mechanical Engineering at the Royal Technical High School, Stuttgart. Third edition, revised and greatly enlarged. Julius Springer, Berlin. 8vo.; pp. 570; numerous illustrations; 18 gelatine plates and many tables. $4.

This is the third and much enlarged edition of Professor Bach's admirable and practical book on the Elasticity and Resistance of the most important structural materials. The author deems it advisable to initiate his readers into the methods used in the practical solution of the problems treated of in the book in order that they may form their own opinions based on actual conditions. The student thus becomes impressed with the fact that he is not dealing with a field which has already been largely threshed out, as is commonly assumed, but is, on the contrary, only in an active state of development. He points out that numerous able mathematicians have advanced formulae more rapidly than their practical knowledge of concrete material seemed to justify, because they neglected the physical aspect, and, therefore, their solutions, otherwise correct, do not always solve practical problems.

In this edition, which is even more fully illustrated than the second, and in which no pains have been spared in typography, will be found many additions relating to the actual work of carrying out the author's investigations.

Among these may be mentioned the much discussed problems of compression of short specimens, flexure of columns and resistance of flat and flanged cast-iron and steel plates and heads. Professor Bach's work in this direction is unique, as he is the first to solve these problems correctly and demonstrate his conclusions by actual tests. It is to be regretted that this valuable work has not yet been translated into English. We can heartily recommend it to any American engineers who read German.

WEALTH AND PROGRESS OF NEW SOUTH WALES, 1896-97.—By T. A. Coghlan, Government Statistician. Tenth issue. Sydney: Government Printer. Boards; 8¾ × 5½ ins.; pp. 1,028.

Mr. Coghlan here gives an interesting historical sketch of Australia, commencing in 1503, but carried out in considerable detail from the actual founding of the English colony at Botany Bay in 1788. The succeeding parts are similar in outline to previous issues, dealing with the area, physical configuration, climate, geology, fauna and flora, of New South Wales. Following this we have the detail of the government, commerce, industries, population, vital statistics, instruction, etc. Under the head of railways we find the history of their development from 1846, to the operation of 2,639 miles of road in 1897. Of this total 2,476 miles are single track, and the average cost per mile is put down at $60,660, in a total expenditure for railways of $100,122,690. For the year ending June 30, 1897, the gross revenue from the government railways of New South Wales was $15,073,710, an increase of $971,625 over the preceding year. The working expenses were $8,006,090, and the net earnings were thus 46.8% of the total earnings. It is interesting to note that while the home government maintains a fleet of ten warships on the Australian station, all the colonies entered into an agreement for ten years with the British government, in 1887, to pay a subsidy towards the maintenance of an Australian auxiliary squadron. This annual subvention amounts, for the whole of Australasia, to $455,000 for maintenance and $175,000 for interest on cost of construction at a 5% rate. The resultant fleet entered Port Jackson in 1891, and consisted of five fast cruisers, of 2,575 tons displacement each, and two torpedo gunboats, of 735 tons; of these, three cruisers and one gunboat are always kept in commission, while the others are held in reserve in Australian ports. But the Australian government has no voice in the management of these vessels or any control over their movements; but this force is always exclusive of the regular fleet maintained in Australian waters, and the British government replaces any vessel lost.

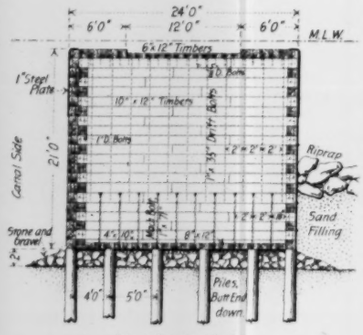
THE RELATIONS BETWEEN CITIES AND TOWNS AND STREET RAILWAY COMPANIES IN MASSACHUSETTS. Report of Special Committee consisting of Chas. F. Adams, of Lincoln; Wm. W. Crapo, of New Bedford, and Elihu B. Hayes, of Lynn; Walter S. Allen, New Bedford, Secretary. Paper; 6 × 9 ins.; pp. 296. Address one of those named above.

In our issue of April 7, 1898, we noticed the advance pages of the body of this report and commented editorially on the bill submitted by the committee to the legislature for establishing the future relations between street railway companies and municipalities. The full report, now before us, contains nearly 250 pages of appendices giving a large amount of valuable information on the subject under discussion. In the first appendix the secretary reviews in detail the history and present status of street railways in Massachusetts. Next there are given brief "Abstracts of the Statutes of the Various States in Relation to Franchises and Methods of Taxation of Street Railways." Then follows a general description of the street railway systems and franchises of 14 American and 22 European cities, this information apparently having been largely obtained by the commission at first hand. An abstract of a paper entitled a "Statement in Relation to Municipal Ownership and Operation of Street Railways in England," by Robt. P. Porter, forms still another appendix, besides which there are others quoting from previous Massachusetts reports bearing on the subject and showing how the law proposed by the commission would affect the revenue from street railways now received by the municipalities and what the various railway companies would have to pay as commutation for relief from the burdens of paving and snow removal now imposed upon them.

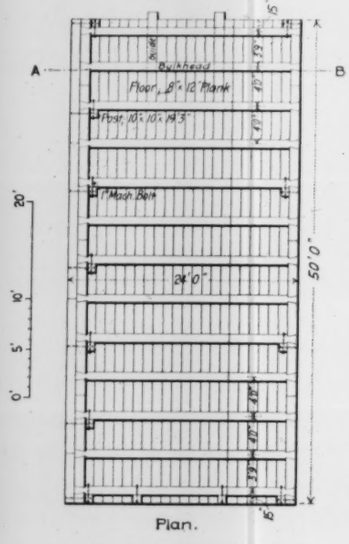
The paper by Mr. Porter is designed to show how the advocates of municipal ownership have misinterpreted English experience in this line. One of his chief arguments is that American capitalists would have done better in these English cities and towns than the municipalities themselves have done. There are certainly good reasons for making the comparison, instead, between public and private ownership in England, and then applying the conclusions to the probable results from public and private ownership in America. We have been very forward in our street railway development under private ownership, but England seems to have been backward in this matter under both private and public ownership. Mr. Porter has omitted at least one factor entering into the present condition of street railway development in England, whether under public or private ownership. He compares the street railway mileage and population of a number of American and English cities, but states the areas of neither; certainly area is an important factor in the case. Nor does he bring out the fact that whereas the capitalization of both public and private street railways in England are closely in accord with their actual cost, many of our American street railway companies are capitalized for many times their legitimate cost, so that under municipal ownership here much lower fares might prevail than are charged by the companies. English conservatism, in some instances, has saved and will continue to save vast sums which American capitalists have recklessly spent in more or less foolish experiments both in adopting new railway methods and making unwarranted extensions. The American plan is to charge all these expenditures to the capital account, instead of to profit and loss, and attempt to earn dividends on them. In other words, the public is called upon to bear the penalty of all the blunders or miscalculations of managers of private railways and often, but not always, has to do so. English managers of private railway companies do not have so much freedom in this respect, which partly explains their conservatism. In Massachusetts, also, the street railway companies are under the wholesome supervision of the State Railway Commissioners, but in most or all of our other American commonwealths these corporations manipulate their capital accounts about as they please.

It is not enough to show, as Mr. Porter attempts to do, that the mileage charges of American street railways are as low or lower than those on the municipal systems of England. The real question at issue is, how do prices in England compare under private and municipal ownership, and how would they compare here?

We do not doubt but that Mr. Porter is entirely right in some of his criticisms of American claims for municipal ownership abroad, and we are glad to say that he appears to have taken great pains to ascertain the facts bearing on the subject. But in interpreting these facts and applying them to American conditions we think he shows himself quite as much a partisan of private ownership as those he is criticising have been partisans of municipal ownership.

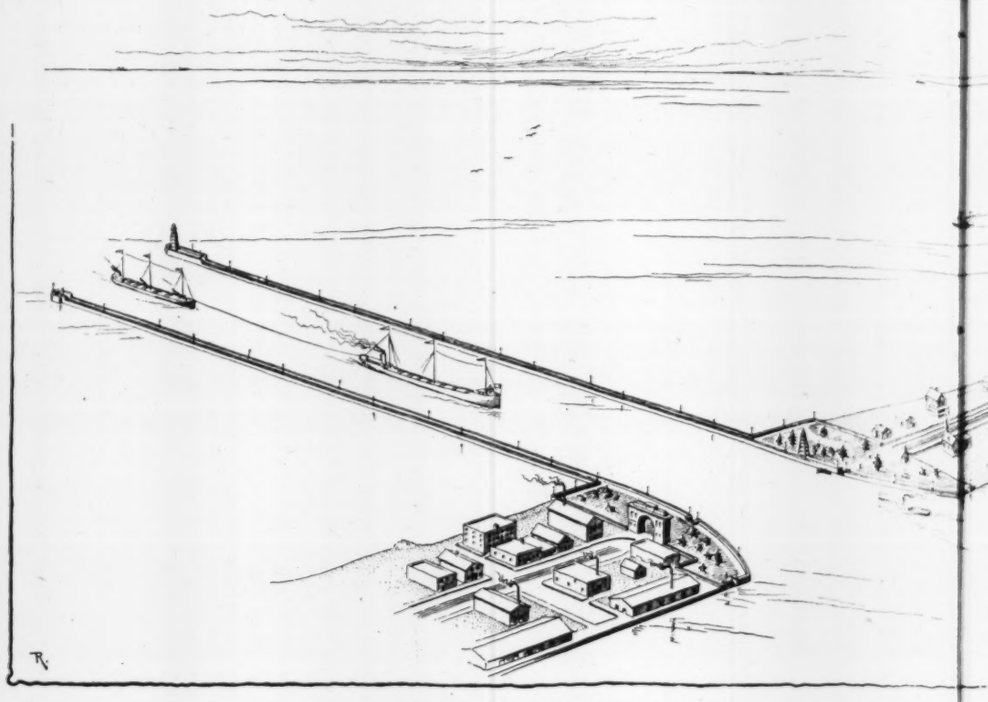


Cross Section A-B.

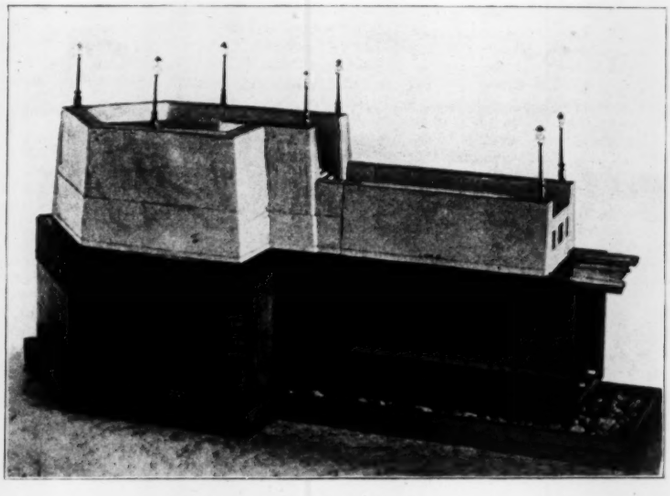


Plan.

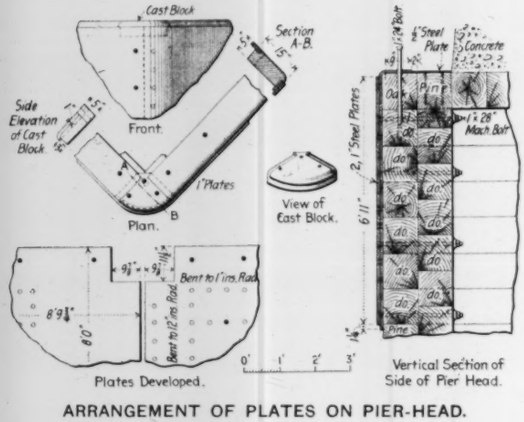
CRIB DETAILS OF MAIN-PIER.



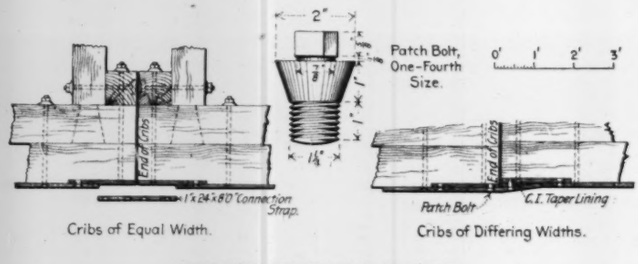
PERSPECTIVE VIEW OF SHIP-CANAL.



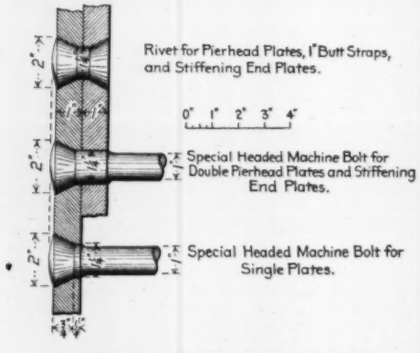
MODEL OF PIER-HEAD AND CRIB.



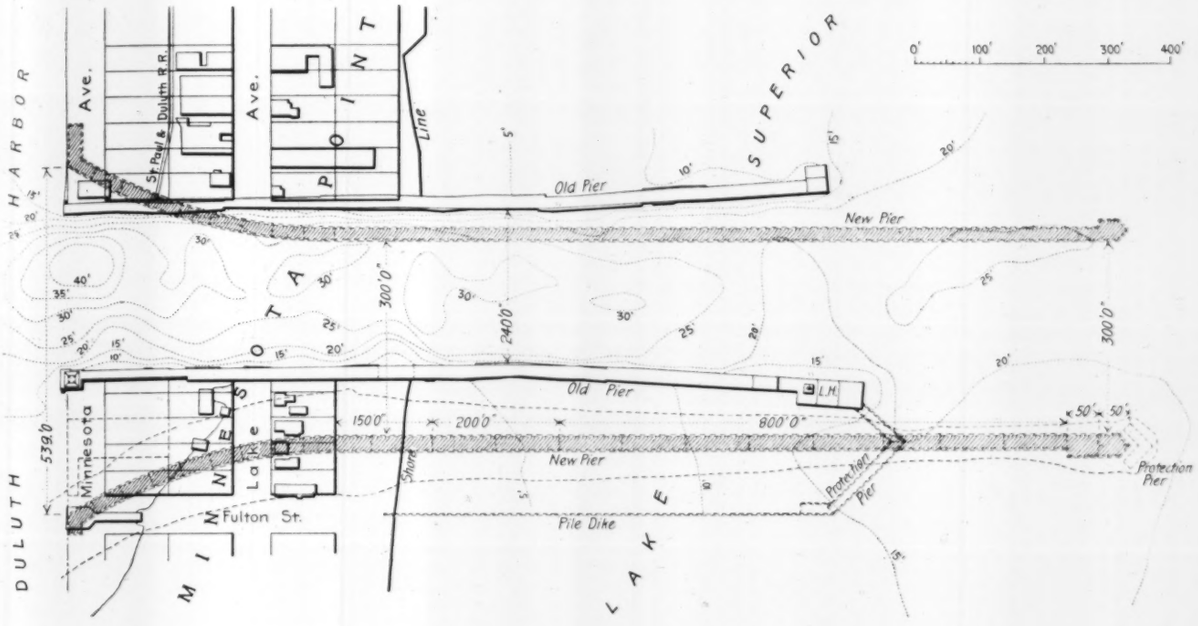
ARRANGEMENT OF PLATES ON PIER-HEAD.



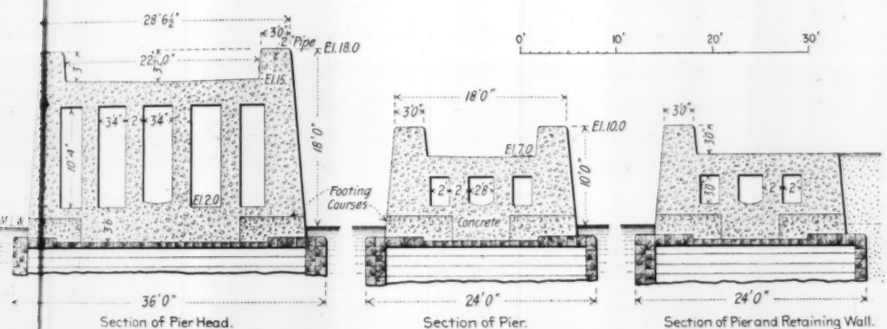
METHOD OF JOINING CRIBS BY CONNECTING STRAPS.


Rivet for Pierhead Plates, 1" Butt Straps, and Stiffening End Plates.
0" 1" 2" 3" 4"
Special Headed Machine Bolt for Double Pierhead Plates and Stiffening End Plates.
Special Headed Machine Bolt for Single Plates.

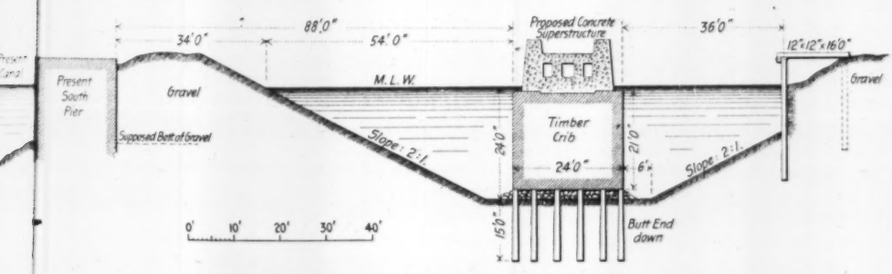
TYPICAL RIVETS AND BOLTS FOR FASTENING PLATES.



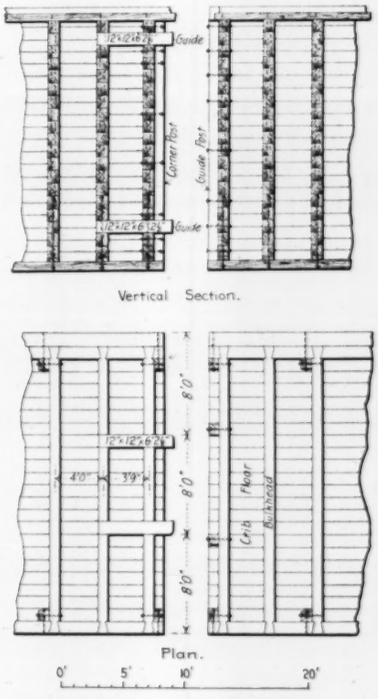
MAP, SHOWING OLD AND NEW PIERS.



TYPICAL CROSS-SECTIONS OF PIER SUPERSTRUCTURE.



CROSS-SECTION THROUGH MINNESOTA POINT.



METHOD OF JOINING CRIBS.

NEW SHIP CANAL ENTRANCE TO HARBOR OF DULUTH, MINN.

Major Clinton B. Sears, Corps of Engineers, U. S. A., Chief Engineer.
J. H. Darling, U. S. Assistant Engineer in Charge.